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Issued June 1960

SOIL SURVEY

Hansford County Texas

OUR SOIL ★ OUR STRENGTH

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
TEXAS AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS REPORT of Hansford County, Texas, will serve several groups of readers. It will help farmers in planning the kind of management that will protect their soils and provide good yields; assist engineers in selecting sites for roads, ponds, buildings, and other structures; aid ranchers in managing ranges; and add to the soil scientist's fund of knowledge.

In making this survey, soil scientists dug holes and examined surface soils and subsoils; measured slopes with a hand level; noticed differences in growth of crops, weeds, and brush; and, in fact, recorded all the things about the soils that they believed might affect their suitability for farming, grazing, and related uses.

The scientists plotted the boundaries of the soils on aerial photographs. Then, cartographers prepared from the photographs the detailed soil map in the back of this report. Fields, roads, rivers, and many other landmarks can be seen on the map.

Locating soils

Use the index to map sheets to locate areas on the large map. The index is a small map of the county on which numbered rectangles have been drawn to show where each sheet of the large map is located. When the correct sheet of the large map has been located, it will be seen that boundaries of the soils are outlined and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they appear on the map. The symbol will be inside the area if there is enough room; otherwise, it will be outside the area and a pointer will show where the symbol belongs.

Finding information

Few readers will be interested in all of the soil report, for it has special sections for different groups of readers, as well as some sections of value to all.

Farmers and ranchers and those who work with them will be interested mainly in the section, Soils of the County, and the section, Use and Management of Soils. The first will aid them in identifying the soils on a ranch or farm. The second tells how the soils can be managed under irrigated farming, dryland farming, or grazing. The guide to mapping units at the back of the report will simplify use of the map and the report. This guide gives the map symbol for each soil, the name of the soil, the page on which the soil is described, the capability unit and range site in which the soil has been placed, and the pages where the capability unit and range site are described.

Engineers will want to refer to the section, Engineering Properties of Soils. Tables in that section show characteristics of the soils that affect their use in building roads, ponds, terraces, and other structures.

Soil scientists will find information about how the soils were formed and how they were classified in the section, Formation of Soils.

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest. The section, General Nature of the Area, will be of interest to those not familiar with the county.

* * *

Fieldwork for this survey was completed in 1957. Unless otherwise specified, statements in this report refer to conditions at the time of survey. This survey is a part of the technical assistance furnished to the Hansford Soil Conservation District, organized in August 1950.

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SOIL SURVEY OF HANSFORD COUNTY, TEXAS

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United States Department of Agriculture in cooperation with the Texas Agricultural Experiment Station

HANSFORD COUNTY, located at the northern edge of the Texas Panhandle, covers an area of 907 square miles (fig. 1). The county is part of a vast grass-

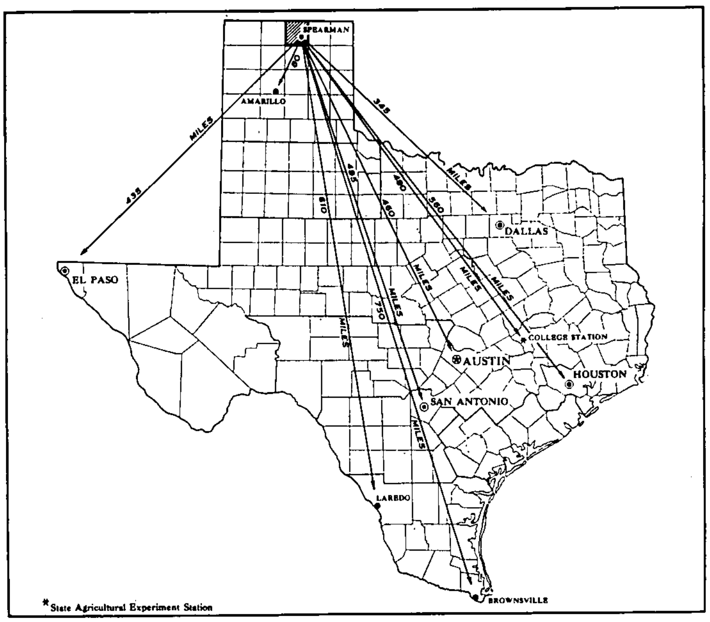

Figure 1.—Location of Hansford County in Texas.

land area known as the High Plains. Irregular rainfall and extremes in temperature limit the choice of crops. Growing of winter wheat and grain sorghum and grazing are the main agricultural enterprises.

General Soil Areas of Hansford County

A general soil area is a pattern of soils on the landscape. The four general soil areas in Hansford County were derived by drawing boundaries around the four distinct kinds of soil patterns in the county. These four areas are shown on the colored map at the back of this report. Their relative positions can be seen in figure 2.

The soils in any given soil area may be alike or distinctly different. Therefore, a map of general soil areas is not suitable for use in planning management on a ranch or farm. Such a map is useful in studying the agriculture of large areas, such as a county, or several counties. It is particularly useful to those who are not acquainted with this area, for it shows the broad relationships among the soils.

Noncalcareous Uplands: Pullman-Zita-Randall-Dalhart

This general soil area is the largest. It covers about 60 percent of the county and consists of nearly level to gently sloping tracts that lie above the caprock and away from the valley breaks. This area appears flat and does not seem to have a definite drainage pattern, except for slight slopes to the intermittent playas. There is no free lime in the soils to a depth of about 12 inches.

Pullman soils occupy about 84 percent of the area; the Zita, 10 percent; the Randall, 2 percent; the Dalhart, 1 percent; and the Spur, Portales, Mansker, Vona, and other soils, a total of about 3 percent.

The Pullman soils cover most of this general area and are considered the normal soils of the noncalcareous uplands. The other soils of this area occur in comparatively small tracts within the Pullman soils.

The Zita soils are more porous and not quite so deep as the Pullman soils. They occur in slightly depressed or slightly sloping places.

The Randall soils are on the beds of intermittent lakes, which are generally circular or oval; they are 2 to 15 feet lower than the soils that surround them. Tracts of the Randall soil range from 4 acres or less to 400 acres or more in size.

The Dahlhart soils are fairly porous soils on slighty elevated ridges or flats in the western part of the county. They are slightly more sandy than the other main soils of this general area.

The Spur, Portales, Mansker, and Vona soils, and some soils of other series, are scattered throughout the general area.

Almost the entire area is used for crops. Wheat and sorghum are the main crops. Under irrigation, some alfalfa and sweetclover can also be grown. Trees are not native, but a few are grown around farmsteads.

Calcareous Uplands: Portales-Mansker

This general soil area occupies about 13 percent of the county. The largest tracts are on the broad divides between Palo Duro Creek and its major tributaries. The tracts are nearly level to gently sloping and are above and bordering the caprock. The soils are shallow to moderately deep and calcareous. If they are not cov-

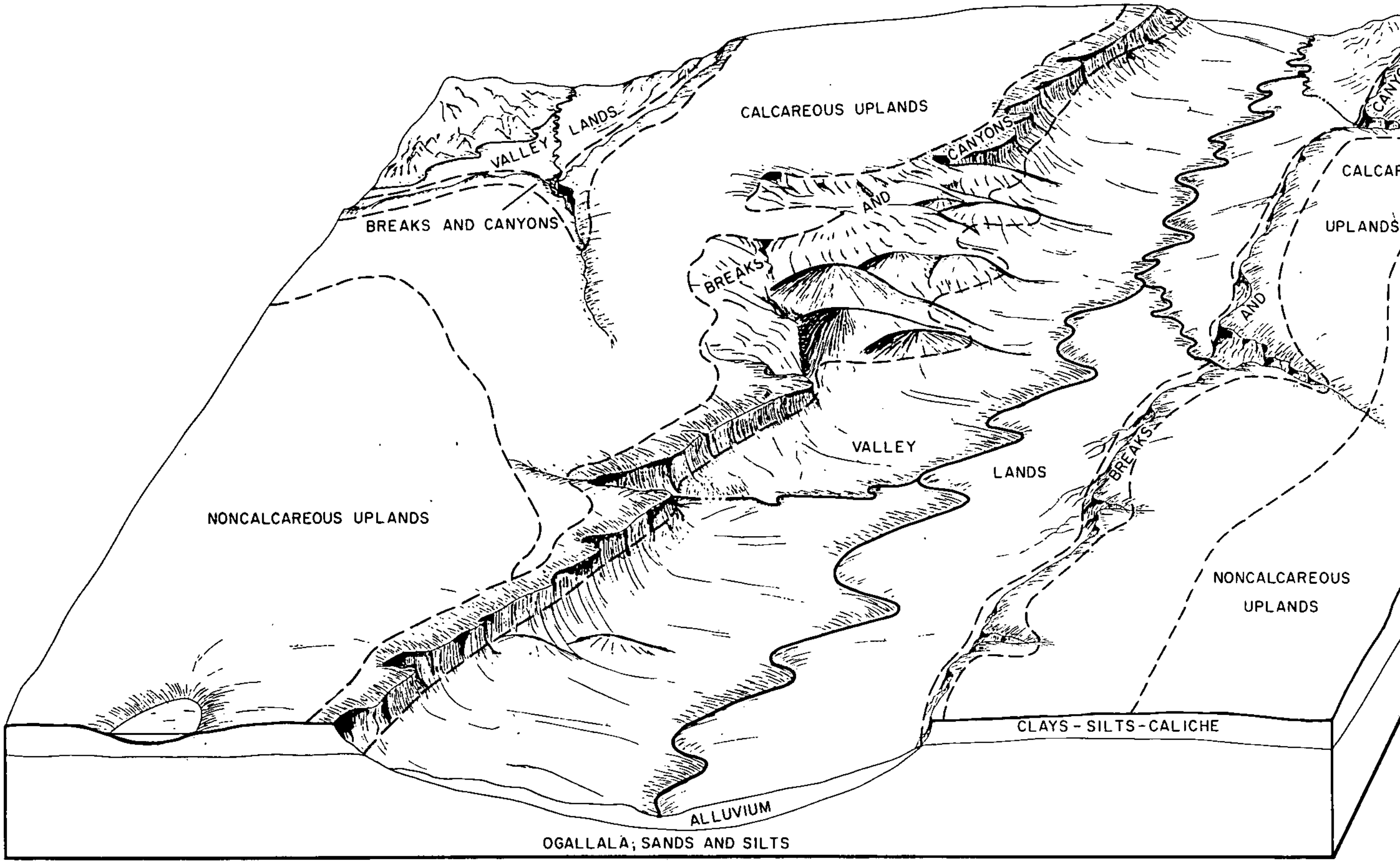

Figure 2.—General soil areas of Hansford County. ***Noncalcareous uplands:*** Pullman-Zita-Randall-Dahlhart; ***Calcareous uplands:*** Por ***canyons:*** Potter-Stony rough land; ***Valley lands:*** Bippus-Mansker-Spur-Sandy alluvial land.

ered by vegetation, they powder easily and blow when the wind is strong.

The Portales soils occupy about 58 percent of the area; the Mansker soils, 38 percent; and the Bippus, Vona, Potter, and other soils, a total of 4 percent.

The Portales soils are high in natural fertility. Generally they occur next to the noncalcareous upland soils that are further removed from the valley escarpments.

The Mansker soils generally occur between the Portales soils and the valley escarpments, but, in places, they appear as shallow ridges or knolls within the Portales soils. They are generally more sloping than the Portales soils, but in some places they are nearly level.

Small areas of Bippus, Vona, and Potter soils, and of a few other soils, are included in this area.

The soils of this area are suitable for crops. Most of them are cultivated, except those on slopes of more than 3 or 4 percent near the valley breaks.

Some of the shallower soils are in native pasture or have been seeded to grass after a few years of cultivation. Dry-farmed wheat and sorghum are the main crops grown. Good yields of alfalfa can be obtained under irrigation.

Breaks and Canyons: Potter-Stony Rough Land

This general soil area occupies about 10 percent of the county. It consists of the rough lands on the escarpments along Coldwater Creek and Palo Duro Creek and their tributaries. In some places the caprock is exposed on the faces of cliffs of hardened caliche; in others it is exposed on steep slopes; and in yet others it has been hidden by steeply rolling, very shallow soils.

The Potter soils occupy about 74 percent of the area; Stony rough land, 22 percent; and the Likes, Mansker, and Bippus soils, with soils of a few other series, less than 4 percent.

The Potter soils are steeply rolling, very shallow, and of varying texture. The caprock, if exposed, is sloping and has few vertical cliffs. It is, therefore, easy for cattle to graze the Potter soils.

Stony rough land, the roughest land in the county, occurs near the caprock that is exposed along escarpments, draws, and canyons. These areas are generally surrounded by Potter soils or, in places, they break off abruptly from some of the smoother, deeper soils. Cattle have difficulty in grazing some of these extremely dissected areas.

Soils of the Likes, Mansker, and Bippus series, and of a few other series, occur in the draws, saddles, and flats throughout the area.

Because slopes are steep and rough, this general area is not suited to crops. It is suited to grazing, and large ranches are located on it.

Valley Lands: Bippus-Mansker-Spur-Sandy Alluvial Land

This general soil area occupies about 17 percent of the county. It is in the valleys of Coldwater Creek and Palo Duro Creek and their tributaries. It consists of the soils of the valley slopes and soils of the nearly level bottom lands.

The Bippus soils occupy about 55 percent of the area; the Mansker, 15 percent; the Spur, 15 percent; Sandy alluvial land, 5 percent; and the Potter, Likes, and Portales soils, 10 percent.

The Bippus soils occur on the slopes of the valleys and up the draws and tributaries. They receive water from higher areas. Runoff is rapid.

The Mansker soils are shallow and sloping and generally border the steeper Potter soils near the breaks. Nevertheless, there are large areas of Mansker soils on ridges in the valleys.

The Spur soils are nearly level to gently sloping soils of the bottom lands.

Sandy alluvial land consists of sandy and mixed flood deposits in the narrow flood plains along Coldwater Creek and the lower part of Palo Duro Creek.

The Potter, Likes, and Portales soils are scattered throughout the valleys.

This general soil area is high in fertility and greatly valued as rangeland. The greater part is in native pasture. Some of the soils on smoother topography are used for wheat and sorghum. Some alfalfa is grown under dryland farming, but more is grown in small irrigated patches scattered throughout the valley. Groves or a few trees of cottonwood, hackberry, and other species are scattered along the major stream channels.

Use and Management of Soils

In this section, management is suggested for the soils of the county. The management is given for groups of soils that need about the same kind of management and that respond to management in about the same way. The groupings used for cultivated crops are called capability units, and the groupings used for range are called range sites. There are two sets of capability units, one for dry-farmed soils, and the other for irrigated soils. The average yields that can be expected from cultivated crops are shown in table 1.

Capability Groups of Soils

Capability grouping is a system of classification used to show the relative suitability of soils for crops, grazing, forestry, and wildlife. It is a practical grouping based on the needs, limitations, and risks of damage to the soils and also on their response to management. There are three levels above the mapping unit in the grouping —unit, subclass, and class.

The capability unit, sometimes called a management group, is the lowest level of grouping. A capability unit is made up of soils similar in management needs, in risks of damage, and in general suitability for use.

The next broader grouping, the subclass, is used to indicate the dominant kind of limitation. The letter symbol "e" indicates that the main limiting factor is risk of erosion either by wind or water; "w" means excess water that retards plant growth or interferes with cultivation; "s" shows that the soils are shallow, droughty, or unusually low in fertility; and "c" shows that the main limitation is climate. When both "e" and "c" are used for a capability unit, there is both an erosion hazard and climatic hazard, and the two are of equal importance.

The broadest grouping, the class, is identified by Roman numerals. All the soils in one class have limitations and management problems of about the same degree, but of different kinds as shown by the subclass. All the classes except class I may have one or more subclasses.

In classes I, II, and III are soils that are suitable for yearly or periodic cultivation of annual crops. Class I soils are those that have the widest range of use and the least risk of damage. They are level or nearly level, productive, well drained, and easy to work. They can be cultivated with almost no risk of erosion and will remain productive if managed with normal care. No soil in Hansford County is in class I.

Class II soils can be cultivated regularly but do not have quite so wide a range of suitability as soils of class I. Some soils of class II are gently sloping; consequently, they need moderate care to prevent erosion. Other soils in class II may be slightly droughty, slightly wet, or somewhat limited in depth. Because of climatic hazards, only irrigated soils are in class II in Hansford County.

Class III soils can be cropped regularly but have a narrower range of use than those in class II. They need even more careful management.

In class IV are soils that should be cultivated only occasionally or only under very careful management.

In classes V, VI, and VII are soils that normally should not be cultivated for annual or short-lived crops but that can be used for pasture and range, as woodland, or for wildlife.

Class V soils are nearly level or gently sloping but are droughty, stony, wet, low in fertility, or otherwise unsuitable for cultivation.

Class VI soils are not suitable for crops, because they are steep, droughty, or otherwise limited, but they produce fair yields of forage. Some soils in class VI can, without damage, be cultivated enough so that pasture crops can be seeded.

Class VII soils provide only poor to fair yields of forage or forest products.

In class VIII are soils that have practically no agricultural use. Some of them have value as watersheds, wildlife habitats, or scenery. No soil of Hansford County is in class VIII.

Capability subclasses and units.—The soils of Hansford County have been placed in capability subclasses and capability units, and management is suggested for each unit. Both dry and irrigated farming are practiced in the county, and, therefore, there are two sets of capability units, one for dry farming, and the other for irrigated. All the soils mapped have been placed in the set of capability units for dry farming. The set of capability units for irrigated farming, however, contains only those soils on which irrigation would be feasible.

Each of the two sets of capability units is introduced by a general discussion of management that includes a descriptive list of the capability units.

Management of Dry Land

The dominant limitations on agriculture in Hansford County are low annual rainfall and high wind velocities in the spring. Dryland management of the soils requires practices that will maintain the supply of organic matter; prevent soil structure from deteriorating; control wind and water erosion; and make efficient use of the limited moisture.

The conservation practices generally used for dryland farming are stubble mulching, terracing, contour farming, and planting of different crops in a sequence, or rotation.

Stubble mulching, widely used in the county, is a system of tilling, planting, cultivating, and harvesting that keeps crop residues on the surface of the soil (fig. 3).

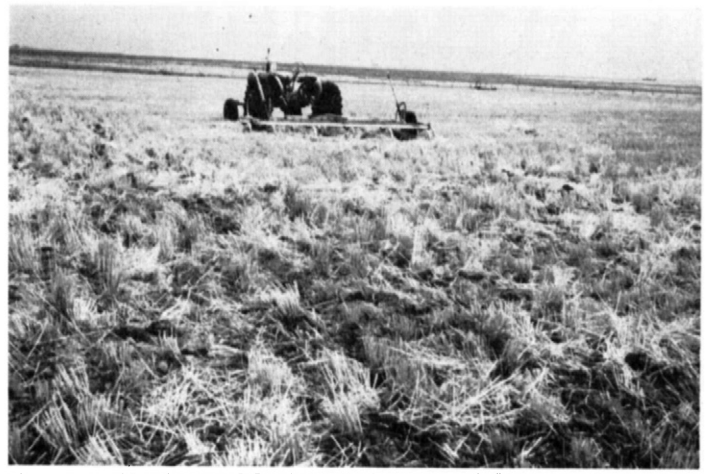

Figure 3.—Stubble-mulch tillage of a wheatfield on Pullman soil.

This practice helps to control wind and water erosion; prevents sealing and crusting of the soil; increases the ability of the soil to absorb water; reduces evaporation of moisture; and helps to maintain the supply of organic matter in the soil.[1]

Stubble mulching can be done best with a blade-type machine or a machine equipped with sweeps 32 inches or more in width. If the soil has a heavy sorghum stubble, it may be best to shred the stubble. The soil will then be easier to work.

Terracing can be done to hold more moisture on the field and to prevent washing (fig. 4). Diversion terraces, used to carry water from long, nearly level areas, will prevent soil from washing down the slope and into low areas. Any terrace system requires suitable outlets for the excess water. If possible, the water outlets should be in pastures. If such a natural grassed drainageway is not available, one should be built.

Contour farming, or the planting of crops on the contour and crosswise to the prevailing slope, checks the flow of water and conserves soil and moisture. Contour farming can be used alone or in combination with terracing.

Cropping systems for dryland farming take into account the amount of moisture available in the soil, the moisture a crop needs to reach maturity, the growing-season temperature the plant requires, and the risk of damage by soil blowing and washing. In this county, the supply of moisture is limited and the growing season is relatively cool. Consequently, crops that require large supplies of moisture or high temperature during

[1] JOHNSON, W. C., STUBBLE-MULCH FARMING ON WHEATLANDS OF THE SOUTHERN HIGH PLAINS. U.S. Dept. Agr. Cir. 860, 9 pp., 1950.

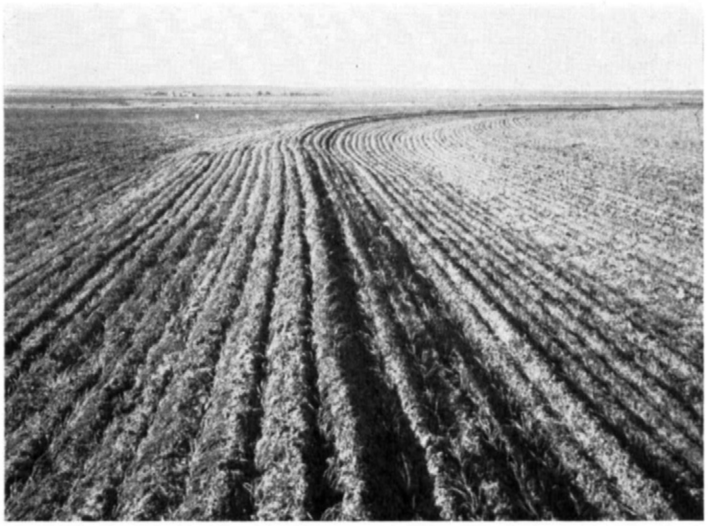

Figure 4.—**Terrace in a wheatfield on gently sloping Pullman soil.**

the growing season, for example, corn or cotton, are seldom grown. The crops most used in dryland farming are wheat and grain sorghum, and the cropping sequence varies widely among the farm operators. The system may be wheat year after year, or wheat for 1 year and grain sorghum for 1 year, or wheat for 1 year and summer fallow for 1 year, or wheat for 1 year, grain sorghum for 1 year, and summer fallow for 1 year.[2] When wheat crops are blown out or fail for other reasons, catch crops of barley, sorghum, millet, or oats are grown.

The cropping system should permit tillage when the moisture content is favorable. Some of the soils compact readily if worked when too moist or nearly wet. A plowpan forms that slows intake of moisture and restricts root growth.

Soils grouped for dryland farming

In the following list the soils of Hansford County are grouped according to their suitability for dryland farming.

Class III.—Soils that have severe limitations and require careful management if tilled; suitable for crops and pasture.
- Subclass IIIe: Sloping soils that have high risk of erosion if tilled.
  - Unit IIIe–1 (D): Deep, gently sloping, noncalcareous silty clay loams.
  - Unit IIIe–2 (D): Deep, gently sloping sandy clay loam and calcareous clay loams.
  - Unit IIIe–3 (D): Deep, nearly level or gently sloping sandy loams.
- Subclass IIIec: Nearly level soils that have moderate risk of wind erosion if tilled, and a severe climatic limitation.
  - Unit IIIec–1 (D): Deep, dark-colored, nearly level, noncalcareous soils.
  - Unit IIIec–2 (D): Deep, moderately dark, nearly level, sandy clay loam or calcareous clay loam soils.

[2] Van Doren, C. E., and Johnson, W. C., fallow and the wind erosion hazard. Soil Conserv. Serv. SCS–TP–11, 9 pp., 1952.

Class IV.—Soils that have severe limitations if tilled; suitable for only limited or occasional cultivation but suited to pasture or trees.
- Subclass IVe: Soils severely limited by risk of erosion if cover is not maintained.
  - Unit IVe–1 (D): Deep, sloping sandy soil and shallow, strongly calcareous, nearly level soils.

Class V.—Soils that have few limitations for pasture plants; not suited to tilled crops.
- Subclass Vw: Soils subject to frequent flooding.
  - Unit Vw–1 (D): Deep, dark-colored, nearly level or gently sloping soils on flood plains, frequently flooded.

Class VI.—Soils that have moderate limitations for pasture or trees; not suited to tilled crops.
- Subclass VIe: Soils subject to rapid erosion if not protected.
  - Unit VIe–1 (D): Deep, sloping to strongly sloping clay loam.
  - Unit VIe–2 (D): Deep, sloping to strongly sloping fine sandy loam.
  - Unit VIe–3 (D): Deep, gently sloping or sloping sandy soils.
  - Unit VIe–4 (D): Very shallow, nearly level to sloping soils and shallow sloping soils.
- Subclass VIw: Level soils subject to frequent overflow.
  - Unit VIw–1 (D): Deep, level clay soil of playas.

Class VII.—Soils not suited to cultivation; severe limitations when used for pasture.
- Subclass VIIs: Soils limited by shallowness.
  - Unit VIIs–1 (D): Very shallow, strongly sloping to steep soils.

Management by dryland capability units

The soils of Hansford County have been placed in 13 capability units for dryland agriculture. Management for each unit is discussed in the pages following. The soils in one capability unit need similar management and respond to that management in about the same way. The deep, fertile soils are grouped according to hazards of wind and water erosion. The hazard of wind erosion is least on noncalcareous clay loams and increases with increase in content of sand, clay, or lime. The hazard of water erosion increases with steepness and length of slope and with decrease in the water-intake rate of the soil.

Management practices suggested for control of wind erosion are designed to afford cover, roughness, and cloddiness sufficient to achieve a practical degree of control.

CAPABILITY UNIT IIIe–1 (D)

Deep, gently sloping, noncalcareous silty clay loams

The soils in this unit are fertile. They are dark colored and have slight hazard of wind erosion and moderate hazard of water erosion. They are—

Pullman silty clay loam, 1 to 3 percent slopes.
Pullman silty clay loam, 1 to 3 percent slopes, eroded.
Zita silty clay loam, 1 to 3 percent slopes.

These soils are suited to small grains and grain sorghum. They are subject to moderate erosion by water, and, because of their fine-textured surface soil, they are

also slightly subject to erosion by wind. Because they take in moisture slowly, runoff increases on the slopes.

The subsoil of the Pullman soils is heavy, and movement of air, moisture, and roots is slow.

These soils should be protected from wind and water erosion. Complete terrace systems, combined with contour farming, are needed. Close-growing crops should be grown, and crop residues are needed on the surface at all times. Suitable cropping systems are wheat year after year, or wheat 1 year and summer fallow 1 year, or a 3-year rotation of wheat, grain sorghum, and summer fallow. These soils are in the Hardland range site.

CAPABILITY UNIT IIIe-2 (D)

Deep, gently sloping sandy clay loam and calcareous clay loams

The soils in this unit are moderately fertile, are moderately dark colored, and have a moderate moisture intake rate. They are—

Bippus clay loam, 1 to 3 percent slopes.
Dalhart sandy clay loam, 1 to 3 percent slopes.
Portales silty clay loam, 1 to 3 percent slopes.

These soils are suited to small grains and grain sorghum. Legumes can be grown occasionally.

The surface soil of these soils is moderately high in lime or in sand. It is easily broken down to particles of erodible size and is subject to severe wind erosion. Because of the gentle slopes, it is susceptible to moderate water erosion.

The subsoil is clayey but porous. It holds moisture well. Movement of air, moisture, and roots is moderate. The root zone is adequate for crops.

These soils need to be protected from wind and water erosion. Wind erosion can be controlled by leaving crop residues on the soils at all times. Suitable cropping systems are wheat year after year, or wheat 1 year and summer fallow 1 year, or a 3-year rotation of wheat, grain sorghum, and summer fallow. A complete terrace system, combined with contour cultivation, is also needed to help protect these soils from water erosion.

The Dalhart and Portales soils are in the Hardland range site. The Bippus soil is in the Hardland slopes range site.

CAPABILITY UNIT IIIe-3 (D)

Deep, nearly level or gently sloping sandy loams

The soils in this unit are moderately dark colored, moderately sandy, and moderately fertile. They have a moderate moisture intake rate. They are—

Bippus fine sandy loam, 1 to 3 percent slopes.
Dalhart fine sandy loam, 0 to 1 percent slopes.
Dalhart fine sandy loam, 1 to 3 percent slopes.
Spur fine sandy loam, high.

These soils are suited to small grains and grain sorghum. Small acreages of cotton are grown occasionally.

The surface soil of these soils is sandy and loose. Rainfall penetrates rapidly. The subsoil is moderately heavy but porous. Movement of air, moisture, and roots is moderate.

These soils are highly susceptible to wind erosion. The more sloping soils are subject to water erosion. Sheet erosion is common, and gullies are formed easily.

These soils need to be covered at all times to protect them from wind and water erosion. Under continued cultivation, there are occasional crop failures and there is severe blowing of the unprotected soils. The wind damages the soils and piles up small sand dunes.

Suitable cropping systems are continuous wheat, or continuous grain sorghum, or 1 year of wheat and 1 year of summer fallow, or a 3-year rotation of wheat, grain sorghum, and summer fallow. If summer fallow is used, delayed fallow is suggested. Tillage should be kept to a minimum, and crop residues are needed on the soil at all times.

Long slopes of less than 1 percent and all slopes of more than 1 percent need a terrace system combined with farming on the contour.

The Dalhart soils are in the Mixed land range site; the Spur soil, in the Dry bottom-land range site; and the Bippus soil, in the Mixed land slopes range site.

CAPABILITY UNIT IIIec-1 (D)

Deep, dark-colored, nearly level, noncalcareous soils

The soils in this unit are fertile but have a slight wind erosion hazard. They are—

Pullman silty clay loam, 0 to 1 percent slopes.
Spur clay loam, high.
Zita silty clay loam, 0 to 1 percent slopes.

These soils are suited to small grains and grain sorghum. During years of average and above average rainfall, sweetclover and winter peas can be grown.

The surface soil of these soils is moderately fine textured and contains much silt and clay. Although the hazard is slight, these soils need adequate protection from wind erosion. The areas on long slopes are also subject to sheet erosion. The subsoil of the Pullman soil is heavy and compact. The compact subsoil restricts movement of air, moisture, and roots. The subsoil of the Zita soil is not heavy and compact, and roots penetrate easily.

Good soil structure can be maintained by adding organic matter to the soils regularly. The organic matter facilitates the movement of moisture and air in the soils.

Stubble mulching and occasional planting of sweetclover and other deep-rooted legumes will help to maintain the content of organic matter. Stubble mulching also serves to control wind and water erosion.

Contour farming on nearly level slopes will help to prevent runoff and will allow water to infiltrate and to be preserved for crops. Diversion terraces or complete terrace systems are needed on some long slopes. If these soils are terraced, contour farming should also be practiced. Without terraces, contour farming can be done with contour guide lines.

The cropping system can be wheat year after year; or wheat for 1 year and summer fallow for 1 year; or a 3-year rotation of wheat, grain sorghum, and summer fallow; or wheat for 1 year and a legume for 1 year.

The Pullman and Zita soils are in the Hardland range site, and the Spur soil is in the Dry bottom-land range site.

CAPABILITY UNIT IIIec-2 (D)

Deep, moderately dark, nearly level, sandy clay loam or calcareous clay loam soils

The soils in this unit are fertile and have a moderate wind erosion hazard. They are—

Dalhart sandy clay loam, 0 to 1 percent slopes.
Portales silty clay loam, 0 to 1 percent slopes.

These soils are suited to small grains and grain sorghum. Sweetclover and summer and winter peas may be grown occasionally.

The surface soil of these soils is moderately loose because it contains much lime and sand. Wind erosion is dominant, but on long slopes sheet erosion may also occur. The subsoil of these soils is moderately heavy and holds moisture well. It is porous and permits moderate movement of air, moisture, and roots.

These nearly level soils retain most of the rainfall. The root zone is deep enough for suitable dryland crops.

On these soils, crop residues need to be carefully managed to help control wind erosion. Cropping systems are wheat year after year; or wheat for 1 year and summer fallow for 1 year; or a 3-year rotation of wheat, grain sorghum, and summer fallow. These crops should be farmed so that some type of cover remains on the surface at all times. Slopes more than a quarter of a mile long may need a diversion terrace or a complete terrace system to control water erosion. Contour farming, used with the terrace system, preserves moisture and thus increases crop yields. These soils are in the Hardland range site.

CAPABILITY UNIT IVe-1 (D)

Deep, sloping sandy soil and shallow, strongly calcareous, nearly level soils

The soils in this unit are moderately dark colored, fertile, and moderate in moisture intake rate. They are—

Bippus fine sandy loam, 3 to 5 percent slopes.
Mansker clay loam, 0 to 1 percent slopes.
Mansker clay loam, 1 to 3 percent slopes.

These soils are suited to small grains, grain sorghum, and sudangrass. However, they are best suited to permanent grass.

These soils are moderately porous. Movement of air, moisture, and roots is moderate. Because the surface soil of these soils is moderately high in lime, the soil particles are easily broken down to erodible size. Wind erosion is a severe hazard. On slopes of more than 1 percent, water erosion is a moderately severe hazard. If the shallow soils of this capability unit are not adequately protected, the root zone is restricted and caliche knobs or white spots appear.

The soils of this capability unit need protection from water erosion. If cultivated, they require a permanent cover. A suitable cropping system is continuous wheat, or wheat for 1 year and stubble-mulch fallow for 1 year, or a 3-year rotation of wheat, grain sorghum, and stubble-mulch fallow. Grain sorghum ought to be planted in closely spaced rows. On the shallower and more eroded areas, grain sorghum may turn yellow because the soils contain so much lime. On such areas it is best to grow wheat or other lime-tolerant crops. It would be even better to plant them to permanent grass.

To control erosion and to conserve moisture, a terrace system is needed on slopes of more than 1 percent. These soils should be farmed on the contour. A cover of sorghum stubble is needed if cultivated soils are planted to grass.

The Mansker soils are in the Hardland slopes range site, and the Bippus soil is in the Mixed land slopes range site.

501170—60——2

CAPABILITY UNIT Vw-1 (D)

Deep, dark-colored, nearly level or gently sloping soils on flood plains, frequently flooded

The soils in this unit are fertile. They are—

Spur clay loam, low.
Spur fine sandy loam, low.
Spur soils.

These soils are subject to frequent flooding from adjacent streams. They are not suited to cultivation but are well suited to grass. They are in the Dry bottom-land range site.

CAPABILITY UNIT VIe-1 (D)

Deep, sloping to strongly sloping clay loam

Bippus clay loam, 3 to 8 percent slopes, is the only soil in this unit. It is a moderately heavy and fertile soil.

Because of its slope, this soil is highly susceptible to water erosion. The subsoil, although moderately heavy, is porous. Air, moisture, and roots move freely through the soil.

This soil is best suited to grass. It is in the Hardland slopes range site.

CAPABILITY UNIT VIe-2 (D)

Deep, sloping to strongly sloping fine sandy loam

Bippus fine sandy loam, 5 to 8 percent slopes, is the only soil in this unit. It is a fertile soil that supports a good growth of native vegetation.

Gullies form easily if the soil is not carefully managed. The moderately sandy surface soil is highly susceptible to wind erosion. Water erosion is also a severe hazard because of the strong slopes.

This soil is not suited to cultivation. It is in the Mixed land slopes range site.

CAPABILITY UNIT VIe-3 (D)

Deep, gently sloping or sloping sandy soils

The soils in this unit are moderately low in fertility. They are—

Likes loamy fine sand, 1 to 8 percent slopes.
Sandy alluvial land.
Vona loamy fine sand, 1 to 5 percent slopes.

These soils support a good growth of tall grasses. They are permeable to air, moisture, and roots.

The surface soil of these soils is very sandy; therefore, permanent cover is needed to prevent active sand dunes from forming. The hazard of severe wind erosion limits the use of these soils to native vegetation. These soils are in the Sandhills range site.

CAPABILITY UNIT VIe-4 (D)

Very shallow, nearly level to sloping soils and shallow sloping soils

The soils in this unit are moderately heavy and moderately fertile. They are—

Mansker clay loam, 3 to 6 percent slopes.
Potter soils, 0 to 8 percent slopes.
Potter-Mansker soils, 0 to 8 percent slopes.

These soils are high in lime. They are sufficiently porous to permit moderate intake of moisture. Movement of air, moisture, and roots through the soils is good. These soils are suitable only for producing native vege-

tation; they are strongly sloping, highly susceptible to water erosion, and shallow or very shallow. These soils are in the Caliche shallow land range site.

CAPABILITY UNIT VIw-1 (D)

Deep, level clay soil of playas

Randall clay, the only soil in this unit, is an extremely heavy dark-colored soil. It receives additional water from surrounding soils and is generally flooded except during periods of drought. It occurs on the beds of wet-weather lakes, or playas, that vary in size and depth. Some of the smaller, shallower lakes are cultivated when dry, but this is risky because of frequent floods. Some of the larger lakes are also cultivated when dry; they are protected by systems to divert waters that would otherwise flow into them. This soil is in the Hardland range site.

CAPABILITY UNIT VIIs-1 (D)

Very shallow, strongly sloping to steep soils

The soils in this unit are moderately fertile. They are—

Potter soils, 8 to 30 percent slopes.
Stony rough land, Potter material.

Because of the steep slopes these soils are highly susceptible to water erosion. Where there is sufficient soil for plant growth, desirable grasses grow in abundance. It is difficult for cattle to graze the steep slopes. These soils are in the Caliche breaks range site.

Management of Irrigated Land

The soils of the High Plains in Hansford County are easily prepared for irrigation. About 72,000 acres is now under irrigation.

About 1907 the first system of irrigation, a flood system, was installed in the northeastern part of the county in the valley of Palo Duro Creek. The creek was dammed, and the water was drawn out in a ditch system. After a few years the dam filled up with silt, the creek changed its channel, and the system was abandoned.

In 1927, a well was drilled in the valley of Palo Duro Creek. Subsequently, other wells were drilled. In the valleys there are at present about 10 irrigation wells, which supply water for about 1,200 acres of Bippus and Spur soils. The water in the wells is 25 to 100 feet below the surface. Several thousand acres of fertile soil in the valleys could be irrigated.

During recent years, many deep-well systems for irrigation have been installed above the caprock. These wells have an average depth of about 400 feet, and the pump setting is at an average depth of 280 feet.

These systems are relatively expensive to install and to operate. However, prices of land and farm products have risen, and natural gas for fuel is available at low cost. Consequently, irrigation is a profitable enterprise if carefully managed.

Increased interest in deep-well irrigation led to the establishment of the North Plains Underground Water District No. 2 in January 1955. Hansford County lies within this district.

In September 1957 there were 226 irrigation wells of all kinds in the county. During recent years, however, the water level has dropped, which indicates removal of water is faster than recharge. It has been estimated that the total supply of ground water should last 60 to 90 years[3] if it is used for supplemental irrigation at a rate of 1 foot per year on one-fourth of the land area. Unless steps can be taken to increase the supply of water, the agriculture of this county will be primarily dryland farming.

Under irrigated farming, crop residues should be shredded or disked and partially incorporated in the surface soil. Crops that improve the soils are needed. Almost all irrigated soils should be fertilized. The kinds and amounts of fertilizer to be applied can be determined after soil tests have been made. On cultivated soils these tests are needed every 2 or 3 years. People working for the Soil Conservation Service or the Agricultural Extension Service can explain how to make these soil tests.

Irrigation has affected the cropping systems. A large acreage is now in grain sorghum and in alfalfa, and many fields produce cotton and other crops that could not be grown under dry farming.

The nearly level Pullman, Portales, and Zita are the principal irrigated soils. Furrow irrigation is most common because these nearly level soils are easy to prepare for irrigation (fig. 5). They need only leveling, smoothing out, or planing. Irrigation must be applied at the correct time and rate, and the length of run should be such that moisture can penetrate to a uniform depth without wastage.

On some nearly level soils a border system of irrigation is used. This type is more efficient than the furrow type, but it is harder to prepare these soils for this kind of irrigation.

The border system of irrigation is designed to make the most efficient use of moisture, taking into consideration depth of soil, water intake rate, amount of irrigation water available, kinds of crops grown, and farm equipment used.

On some gently sloping soils bench leveling is practiced. The leveled areas are on the contour and look like steps on the landscape. Each level, or bench, has its own system of border irrigation.

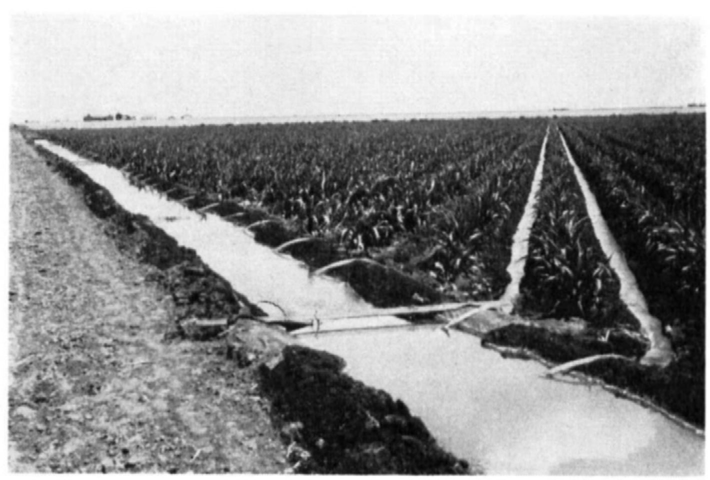

Figure 5.—Row irrigation of grain sorghum on nearly level Pullman soil.

[3] FINNELL, H. H., FUTURE OF THE SOUTHERN GREAT PLAINS. Soil Conserv. 23: 57–59, illus. 1957.

The sprinkler system of irrigation is not used extensively.

Soils grouped for irrigated farming

The soils of Hansford County suitable for irrigation have been placed in the following capability classes, subclasses, and units.

Class II.—Soils that have moderate limitations if tilled; suitable for crops, pasture, and trees.
- Subclass IIe: Soils subject to erosion if unprotected.
  - Unit IIe-1 (Ir): Deep, fertile soils that have loamy subsoils.
  - Unit IIe-2 (Ir): Deep fine sandy loams and calcareous silty clay loam.
- Subclass IIs: Soils with root zone limitations.
  - Unit IIs-1 (Ir): Soil moderately limited by compact subsoil.

Class III.—Soils that have severe limitations and require careful management if tilled; suitable for crops, pasture, and trees.
- Subclass IIIe: Gently sloping soils subject to erosion if unprotected.
  - Unit IIIe-1 (Ir): Deep, gently sloping soil that has a clayey subsoil.
  - Unit IIIe-2 (Ir): Deep, gently sloping silty clay loam and sandy clay loam soils that have loamy subsoils.
  - Unit IIIe-3 (Ir): Deep, gently sloping, calcareous silty clay loam and clay loam.
  - Unit IIIe-4 (Ir): Deep, gently sloping fine sandy loams.
  - Unit IIIe-5 (Ir): Shallow, calcareous clay loams.

Class IV.—Soils that have severe limitations if tilled; suitable for only limited or occasional cultivation but suitable for pasture or trees.
- Subclass IVe: Soils severely limited by risk of erosion if cover is not maintained.
  - Unit IVe-1 (Ir): Deep, moderately dark colored, sloping fine sandy loam.

Management by irrigated capability units

The soils of Hansford County suitable for irrigation have been placed in nine capability units. A description of each unit, a list of the soils it contains, and suggestions for use and management are given in the pages that follow.

CAPABILITY UNIT IIe-1 (Ir)

Deep, fertile soils that have loamy subsoils

The soils in this unit are fertile. They have a moderate moisture intake rate. They are—

Dalhart sandy clay loam, 0 to 1 percent slopes.
Spur clay loam, high.
Zita silty clay loam, 0 to 1 percent slopes.

These soils are suited to small grains, grain sorghum, sudangrass, alfalfa, sweetclover, vetch, and summer and winter peas.

The subsoil of these soils is moderately heavy, but movement of air, moisture, and roots is good.

These soils respond well to fertilizer. If they are continuously cropped, they need good management. Otherwise, they will become less fertile and will lose their good structure.

Plowpans, or compacted zones, commonly occur just below the plow layer. They slow down intake of moisture and restrict the root zone. If deep-rooted legumes are used and the soils are tilled at the proper time at the correct depth, the plowpans can be broken up. Wind and water erosion are slight, though constant, hazards.

To maintain good soil structure and high fertility, a cropping system that contains a soil-improving crop at least every 3 years is needed. A rotation consisting of wheat for 2 years and a legume for 1 year would be suitable. Sometimes the wheat is overseeded with hubam. A rotation that includes alfalfa is also common and practical. All residues should be left on the surface. Heavy wheat stubble is commonly shredded with a rotary blade.

If nitrogen is added to crop residues, it will hasten decay of the residue. This is considered a good soil-improving practice. Most of these soils need fertilizer to produce good yields. The types and amounts of fertilizer needed for a particular soil and crop will vary and should be determined by soil tests.

CAPABILITY UNIT IIe-2 (Ir)

Deep fine sandy loams and calcareous silty clay loam

The soils in this unit are nearly level and clayey or moderately sandy. They are fertile and have a moderate moisture intake rate. They are—

Dalhart fine sandy loam, 0 to 1 percent slopes.
Portales silty clay loam, 0 to 1 percent slopes.
Spur fine sandy loam, high.

These soils are suited to small grains, grain sorghum, sudangrass, alfalfa, sweetclover, vetch, and summer and winter peas.

The root zone is adequate for crops. The subsoil of these soils is moderately heavy and porous. Movement of air, moisture, and roots through the subsoil is good. The surface soil is somewhat loose, and it is highly susceptible to wind erosion when not protected by cover.

If these soils are continuously cropped, they should be carefully managed; otherwise, they will deteriorate in tilth and fertility. Plowpans commonly occur just below the plow layer. These pans slow down the intake of moisture and restrict the root zone.

The cropping system should include a soil-improving crop at least once every 3 years. A good 3-year rotation is wheat for 2 years and a legume for 1 year. Sometimes wheat is overseeded with hubam. Alfalfa is also used in a rotation. Fertilizer will increase yields. Soil tests can be made to determine the kinds and amounts of fertilizer needed.

Plant residues should be left on the surface as late as possible in spring, to control wind erosion. When the soils are not protected by residues or growing crops, they should be kept cloddy and rough. Where runoff from higher soils is a hazard, diversion terraces are needed.

CAPABILITY UNIT IIs-1 (Ir)

Soil moderately limited by compact subsoil

Pullman silty clay loam, 0 to 1 percent slopes, is the only soil in this unit. It is nearly level and very heavy.

This soil is suited to small grains, grain sorghum, alfalfa, sweetclover, vetch, and Austrian winter peas.

Most of the irrigation in the county is on this soil (fig. 6). Movement of air, moisture, and roots through the subsoil is very slow, but the subsoil can hold a large amount of moisture. Before planting, it is difficult to apply enough irrigation water to reach the storage capacity of the subsoil.

This soil must be carefully managed under irrigation; otherwise, it will become less fertile and increasingly more difficult to irrigate.

Figure 6.—**Irrigated hybrid grain sorghum on Pullman silty clay loam. Rows were spaced 20 inches apart, and nitrogen and phosphate fertilizer were applied. The yield was 6,500 pounds per acre.**

In many places there are plowpans, or compacted zones, just beneath the plow layer. These reduce intake of moisture and greatly restrict the root zone. Wind and water erosion are slight but constant hazards.

Under irrigated farming, a cropping system that maintains soil structure and fertility is needed. A deep-rooted legume should be included in the rotation every 3 years. A cropping system of wheat for 2 years and a legume for 1 year is good; sometimes the wheat is overseeded with hubam in this rotation. Hubam is a good soil conditioner; it helps to maintain high fertility, especially if it is used as a green-manure crop.

Plant residues should be mixed in the first few inches of the surface soil to control erosion and to prevent the surface from crusting. In some instances this is done by shredding with a rotary blade and then disking or plowing. If nitrogen is added to crops that produce much residue, it will hasten decay of the residue. This is considered a soil-improving practice.

This soil responds to fertilizer, which should be applied if soil tests indicate it is needed.

CAPABILITY UNIT IIIe–1 (Ir)

Deep, gently sloping soil that has a clayey subsoil

Pullman silty clay loam, 1 to 3 percent slopes, is the only soil in this unit. It is a gently sloping, fertile soil that has a slow moisture intake rate.

This soil is suited to small grains, grain sorghum, sudangrass, alfalfa, sweetclover, vetch, and summer and winter peas.

This soil has a compact, heavy subsoil. Movement of air, moisture, and roots is very slow and in many places it is restricted by a plowpan. Bench leveling is needed for efficient irrigation. This soil is susceptible to moderate water erosion and is moderately susceptible to wind erosion.

Diversion terraces are needed to protect this soil from excessive runoff from the surrounding soils. Every other year the cropping system should include a deep-rooted legume or other soil-improving crop. A good cropping system is wheat for 1 year and a legume for 1 year; or wheat for 1 year and wheat with fertilized stubble for 1 year. In many places alfalfa is included in the rotation.

Crops should be farmed in such a way that crop residues will be mixed in the upper few inches of the soil. In many places heavy stubble is shredded with rotary blades and then nitrogen is added to hasten decay and to improve the soil. To increase yields, fertilizer should be added in amounts indicated by soil tests.

CAPABLITY UNIT IIIe–2 (Ir)

Deep, gently sloping silty clay loam and sandy clay loam soils that have loamy subsoils

The soils in this unit are fertile. They are gently sloping, are clayey, and have a slow to moderate moisture intake rate. They are—

Dalhart sandy clay loam, 1 to 3 percent slopes.
Zita silty clay loam, 1 to 3 percent slopes.

These soils are suited to small grains, grain sorghum, sudangrass, alfalfa, sweetclover, vetch, and summer and winter peas.

These soils have a moderately heavy subsoil that holds moisture well. Movement of moisture, air, and roots is fair. In many places compacted zones, or plowpans, restrict intake of moisture and the root zone. These soils are susceptible to severe water erosion and are moderately susceptible to wind erosion.

A cropping system that includes a soil-improving crop every other year will help to maintain soil structure and organic matter. Deep-rooted legumes will improve the soils, as will crops that produce much residue.

If crop residues are used, they will benefit the soils most if they are fertilized. A suitable rotation might be wheat for 1 year and a legume for 1 year, or wheat for 1 year and wheat with fertilized stubble for 1 year. Generally, wheat is overseeded with hubam, but alfalfa may be used in the rotation. Crop residues ought to be mixed into the surface layer; heavy wheat stubble may be shredded with a rotary blade.

Diversion terraces should protect these soils from runoff from the surrounding soils. To increase yields, fertilizer should be added in amounts indicated by soil tests.

CAPABILITY UNIT IIIe–3 (Ir)

Deep, gently sloping, calcareous silty clay loam and clay loam

The soils in this unit are clayey, gently sloping, and moderately fertile. They have a moderate moisture intake rate. They are—

Bippus clay loam, 1 to 3 percent slopes.
Portales silty clay loam, 1 to 3 percent slopes.

These soils are suited to small grains, grain sorghum, sudangrass, alfalfa, sweetclover, vetch, and summer and winter peas.

The subsoil of these soils is moderately heavy and can absorb a fair to good amount of moisture. Air, moisture, and roots move freely. These soils are subject to moderate water and wind erosion if unprotected.

A cropping system of wheat for 1 year and a legume for 1 year, or wheat for 1 year and wheat with fertilized stubble for 1 year, is suitable. Wheat is overseeded with hubam, which is excellent for improving the soil. Alfalfa is included in some rotations. Deep-rooted legumes and fertilized crop residues are also used. Crop residues mixed in the surface layer will help to prevent wind erosion and will provide organic material. Where there is excessive runoff from surrounding soils, diversion terraces should be built. For improved yields, fertilizers are generally needed. The kinds and amounts of fertilizer needed can be determined by making soil tests.

CAPABLITY UNIT IIIe-4 (Ir)

Deep, gently sloping fine sandy loams

The soils in this unit are moderately sandy and nearly level to gently sloping. They take in moisture rapidly and are moderately fertile. They are—

Bippus fine sandy loam, 1 to 3 percent slopes.
Dalhart fine sandy loam, 1 to 3 percent slopes.

These soils are suited to small grains, grain sorghum, sudangrass, alfalfa, vetch, and summer and winter peas.

These soils have a light to moderately heavy subsoil, which is sufficiently heavy to hold fair but adequate amounts of moisture. Because the surface soil is loose, it absorbs moisture rapidly and is highly susceptible to wind erosion. The stronger slopes are moderately susceptible to water erosion. Air, moisture, and roots move freely through these soils.

These soils are best suited to sprinkler irrigation, but other systems of irrigation are suitable.

A cropping system that provides surface cover or cloddiness or roughness at all times is needed.

A suitable cropping system is wheat for 1 year and wheat with fertilized stubble for 1 year, or a rotation of wheat for 1 year and alfalfa for 2 years. Deep-rooted crops and fertilized crop residues help to improve the soils. Fertilizers are generally needed to increase yields. The kinds and amounts of fertilizer needed can be determined after making soil tests.

CAPABLITY UNIT IIIe-5 (Ir)

Shallow, calcareous clay loams

The soils in this unit are nearly level to gently sloping. They are fertile and take in moisture at a moderate rate. They are—

Mansker clay loam, 0 to 1 percent slopes.
Mansker clay loam, 1 to 3 percent slopes.

These soils are suited to small grains, grain sorghum, sudangrass, sweetclover, alfalfa, vetch, and summer and winter peas.

The surface soil of these soils is porous. The subsoil is granular, porous, and not deep. It holds a moderate quantity of moisture. Air, moisture, and roots move very freely through the subsoil. The shallow depth to caliche restricts the root zone and makes bench leveling and other mechanical practices impractical. The depth to caliche varies from 1 to 2 feet.

The surface layer of these soils is subject to severe wind erosion. It is high in lime and breaks down easily. The areas on the stronger slopes are highly susceptible to water erosion.

A suitable cropping system is wheat for 1 year followed by biennial sweetclover, or wheat for 1 year followed by wheat with fertilized stubble for 1 year. Alfalfa is often used in a crop rotation. Deep-rooted legumes and crop residues that are fertilized with nitrogen will improve the soils. All crop residues should be mixed in the upper few inches of the surface soil. Heavy stubble may be shredded with a rotary blade.

A suitable irrigation system is needed. Depth of soil, other soil characteristics, and crops to be grown are factors to be considered in planning an irrigation system. Fertilizers should be added after soil tests are made.

CAPABILITY UNIT IVe-1 (Ir)

Deep, moderately dark colored, sloping fine sandy loam

Bippus fine sandy loam, 3 to 5 percent slopes, is the only soil in this unit. It is moderately sandy and moderately fertile. It has a moderately rapid moisture intake rate.

The soil is suited to small grains, grain sorghum, sudangrass, alfalfa, sweetclover, vetch, and summer and winter peas. Irrigated pastures of permanent grass are well suited.

The surface soil is light, and the subsoil, moderately heavy. Air, moisture, and roots move very freely through this soil. The root zone is deep.

Because of its loose surface soil, this soil is highly susceptible to wind erosion. It is also highly susceptible to water erosion. Gullies form easily.

This soil is best suited to sprinkler irrigation. If other irrigation systems are used, bench leveling is needed.

Deep-rooted legumes and other soil-improving crops or fertilized crop residues are needed each year to maintain fertility.

A cropping system is needed that will leave some crop residues on the soil at all times. A suitable system is continuous alfalfa, or wheat for 1 year and biennial sweetclover. Soil tests should be made to determine the need for fertilizer.

Estimated Yields

Average acre yields to be expected on the soils of Hansford County are shown in table 1. In columns A are yields to be expected under unimproved management, and in columns B are yields to be obtained under improved management. Only the soils normally used for crops are listed in the table.

Under unimproved management, few of the needed management practices and some detrimental practices may be followed. Among the undesirable practices are burning of crop residues, tilling wet soils, and overgrazing wheat and grain-sorghum stubble.

Under improved management, the better practices are followed. These are the practices mentioned for each capability unit in the subsections, Management of Dry Land, and Management of Irrigated Land. Among these practices are growing of crops that produce a large amount of residue, contour farming, terracing, and rotating crops. Improved varieties of crops are planted, and the seed is properly treated.

TABLE 1.—*Estimated average acre yields for cultivated soils*

[Yields in columns A are to be expected under unimproved management; those in columns B are to be expected under improved management. Absence of yield indicates that crop is not suitable under the management specified. Soils not listed in this table are not used for cultivated crops]

Soil	Wheat				Grain sorghum				Barley				Oats				Alfalfa			
	Dryland		Irrigated		Dryland		Irrigated		Dryland		Irrigated		Dryland		Irrigated		Dryland		Irrigated	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*
Bippus fine sandy loam, 1 to 3 percent slopes	4	6	21	30	9	12	45	64	7	10	20	29	5	10	18	27	----	----	4	6
Bippus clay loam, 1 to 3 percent slopes	7	9	22	36	11	15	49	73	6	9	24	32	8	13	27	40	----	----	4	6½
Dalhart sandy clay loam, 0 to 1 percent slopes	7	10	25	36	13	20	54	82	9	12	28	37	11	17	35	44	----	----	5	6½
Dalhart sandy clay loam, 1 to 3 percent slopes	6	9	21	34	11	17	47	70	9	11	23	34	10	15	31	44	----	----	4	6
Dalhart fine sandy loam, 0 to 1 percent slopes	6	8	18	30	10	15	47	75	10	14	26	35	9	15	21	29	----	----	4½	6½
Dalhart fine sandy loam, 1 to 3 percent slopes	5	7	----	----	9	14	----	----	8	12	----	----	7	12	----	----	----	----	----	----
Mansker clay loam, 1 to 3 percent slopes	6	8	----	----	6	9	----	----	5	9	----	----	6	14	----	----	----	----	----	----
Mansker clay loam, 0 to 1 percent slopes	7	9	20	33	10	14	36	47	6	9	12	26	8	15	26	32	----	----	3½	4½
Portales silty clay loam, 0 to 1 percent slopes	9	11	27	37	11	15	40	64	7	10	27	36	12	19	36	47	----	----	4	5¾
Portales silty clay loam, 1 to 3 percent slopes	7	10	21	35	10	14	35	55	6	9	24	30	12	19	31	43	----	----	3½	5½
Pullman silty clay loam, 0 to 1 percent slopes	9	11	31	50	13	20	55	91	9	13	31	43	11	14	39	53	----	----	5½	6
Pullman silty clay loam, 1 to 3 percent slopes	8	10	26	40	10	15	45	75	7	11	26	41	8	11	33	53	----	----	5	5½
Pullman silty clay loam, 1 to 3 percent slopes, eroded	4	8	----	----	8	12	----	----	4	8	----	----	6	10	----	----	----	----	----	----
Spur clay loam, high	10	11	30	45	15	22	57	85	9	13	33	47	14	21	36	54	----	----	6	7
Spur fine sandy loam, high	7	10	29	41	14	20	54	79	8	10	31	45	12	17	31	47	----	----	6	7
Zita silty clay loam, 0 to 1 percent slopes	9	12	31	45	14	23	54	86	8	12	27	38	12	15	34	51	----	----	5	6½
Zita silty clay loam, 1 to 3 percent slopes	7	10	28	36	11	19	49	84	7	11	21	36	9	13	27	46	----	----	4	6

When a season of fallow is included in a cropping system, yields obtained the season after fallowing will average about 60 percent higher than when fallow is not used.

Range Management

About a third of the acreage in Hansford County is used for grazing. Most of this rangeland is on shallow soils not suited to cultivation but well suited to grasses. Heavy grazing has seriously reduced the stand of better grasses and allowed an increase in less desirable grasses and woody plants.

One of the primary purposes of range management is to bring back a vigorous stand of the desirable grasses. The success of livestock raising depends on how well this is done. A measure of the success achieved is the pounds of beef produced per acre.

To manage efficiently, a rancher needs to learn about the grasses on his range. Different grasses have different habits of growth. Western wheatgrass, for example, grows best in cool seasons; blue grama grows in warm weather. Sand bluestem does well on lowlands and sandhills. Buffalograss and similar less productive grasses grow well on silty clay loams of the uplands. Grasses that spread from underground stems can be grazed closer, without damage, than grasses that spread on the top of the ground or that reproduce from seed. Consider habits of growth in managing the range. Otherwise, the stand may be injured or the yield may be lower than it could have been.

Proper number of livestock.—The number of livestock to be grazed on the range should be decided according to the length of time that the range can be used safely and the amount and condition of forage available. Enough forage should be left on the ground to—

1. Permit deep, vigorous growth of grass roots. Enough green leaves should remain on each plant to provide food that will be stored in the roots and get the plant off to early and vigorous growth in spring.
2. Provide mulch for the soil and thus increase capacity to absorb and store water. More soil moisture means more grass.
3. Protect the soil from wind and water; a good grass cover will control erosion.
4. Allow grass to crowd out weeds and other inferior plants. This will improve range in poor or fair condition.

5. Stop snow so that it can soak into the soil when it melts; snow blown into drifts melts in drainageways and in areas covered by woody plants, where it is of little benefit to the range.
6. Provide a feed reserve for periods of drought that might otherwise force sale of livestock at a time when prices are low.

Kind of livestock.—Select the kind of livestock that will make the best gains and will be least likely to damage the range. The range in Hansford County is best suited to cattle. It is not particularly suited to goats, because the range does not provide enough woody browse plants.

Distribution of grazing.—Many large ranges in Hansford County are overgrazed in some parts and undergrazed, or not grazed, in others. Fences are needed to provide separate pastures for different classes of livestock and to permit grazing at the season appropriate for the kinds of grasses in the various sites. Where practical, locate fences on the boundary between sites that grow grasses of different palatability. Otherwise, the livestock will overgraze the site producing the palatable grasses and undergraze the other site. Temporary fences can be used if it is not practical to put up permanent fences.

Place salt in lightly grazed areas where livestock can reach it from several directions, but do not put it in easily eroded areas. To avoid uneven grazing, provide watering places over the entire pasture so that the livestock will not have far to walk. If uneven grazing continues, even though fences, salt, and water are properly located, the number of livestock ought to be reduced or grazing changed to a different season.

Season of use.—The range site and the growth habits of the grasses in the site determine the best season of use. Western wheatgrass, for example, makes much of its growth in cool seasons and, therefore, should be grazed in cool seasons. Cool-season grasses are damaged by heavy grazing in winter and early in spring. Move livestock from the pasture when they have taken about half of the current year's growth from the better grasses.

Deferred grazing.—All ranges need a rest at times, and those that are in poor or fair condition need more time to recover. Remove all livestock from the range. If the range has been grazed short, give it a longer rest so that the grasses may regain vigor. The time for deferred grazing depends on the kinds of grasses to be improved. As a general rule, deferred grazing is needed on all ranges after seeding, brush control, or range pitting or furrowing.

Brush control, seeding, and other practices.—If yucca and other woody plants are seriously competing with grass for food and water, the range ought to be cleared. Cactus increases during drought years; control it as soon as it invades a range.

Range pitting or furrows can be used where drought or overgrazing have damaged the grasses. If ranges are properly stocked, these emergency measures will seldom be needed. Some denuded areas will recover more rapidly if they are seeded.

Range sites

Management of rangeland is more easily understood if the soils are placed in range sites. A range site is an area having a distinctive combination of climate, soils, topography, and drainage, and, consequently, a definite combination of plants. The combination of plants that originally grew on the site is called climax vegetation. As a rule, this climax vegetation is the most productive combination of plants that will grow on the site. Also, it provides the best protection against erosion.

The climax vegetation consists of two classes of plants: Decreasers and increasers. Decreasers are the most heavily grazed; therefore, they are the first destroyed by overgrazing. Increasers withstand grazing better, or are less palatable to livestock. They increase under grazing and replace the decreasers. Invaders are plants that come in after the climax vegetation has been reduced by grazing.

Generally, two or three species of native grasses are dominant in the climax vegetation of a range site. For example, in the Hardland site, blue grama and buffalograss are predominant. Several other grasses grow, but blue grama and buffalograss constitute more than 75 percent of the total forage on the site. If the Hardland range site is grazed in such a way that these two grasses are still dominant, then the range site is probably producing almost the maximum of forage. This is also true for the other sites; they produce the most forage over a long period if the grasses most closely resemble the original vegetative cover.

Range condition.—Overgrazing, burning, and trampling upset the balance between climax vegetation and the environment the range site provides. The range deteriorates, and the degree of deterioration is called *range condition.* The ratings for range condition—excellent, good, fair, and poor—measure the present productivity of the grasses. A range site in excellent condition has not deteriorated much; 75 to 100 percent of its vegetation consists of the original climax grasses. The productivity of native grasses is used in estimating range condition because the combination of grasses that will produce the most beef in the county is generally the one that was there when the first white men came. The condition of a range is determined by comparing the kind and amount of present vegetation with the climax vegetation. The condition depends much on how the soils are managed.

The eight range sites in Hansford County are described on the following pages. The soils in a given site support about the same kinds and amounts of native plants. Stocking rates are not suggested for the various sites, because the weather varies from year to year. Adjustments in numbers of livestock are needed to meet the changes in growth resulting from changes in weather.

Knowledge of the various range sites on a ranch, and of the desirable practices of range management discussed on the foregoing pages, is the basis for efficient use of pasture. Detailed information on stocking rates, seeding, brush removal, pitting or furrowing, and other practices of management can be obtained from a local representative of the Soil Conservation Service. He can suggest treatment for a particular tract of rangeland. The suggestions in this report, of necessity, are general.

HARDLAND SITE

This range site is in level to gently sloping areas. The soils contain much clay. The relationship between plants, soil, and moisture is only fair. If this site is in excellent condition, the growth is blue grama, vine mesquite, some western wheatgrass, and buffalograss; there are no shrubs. If the site deteriorates to fair or poor condition, perennial three-awn, sand dropseed, western ragweed, broom snakeweed, pricklypear, and annual forbs and grasses will invade. The soils in this site are—

Dalhart sandy clay loam, 0 to 1 percent slopes.
Dalhart sandy clay loam, 1 to 3 percent slopes.
Portales silty clay loam, 0 to 1 percent slopes.
Portales silty clay loam, 1 to 3 percent slopes.
Pullman silty clay loam, 0 to 1 percent slopes.
Pullman silty clay loam, 1 to 3 percent slopes.
Pullman silty clay loam, 1 to 3 percent slopes, eroded.
Randall clay.
Zita silty clay loam, 0 to 1 percent slopes.
Zita silty clay loam, 1 to 3 percent slopes.

This site accounts for about 17.3 percent of the total rangeland.

HARDLAND SLOPES SITE

This range site is on the edge of the level to gently sloping plains that border on the Caliche shallow land site. It also occurs below the two caliche sites on long slopes. The relationship between plants, soil, and moisture is fair to good. If this site is in excellent condition, the growth is side-oats grama, vine mesquite, little bluestem, and blue grama; there are no shrubs. If the site deteriorates to fair or poor condition, perennial three-awn, sand dropseed, western ragweed, broom snakeweed, yucca, and annual grasses and forbs invade. The soils in this site are—

Bippus clay loam, 1 to 3 percent slopes.
Bippus clay loam, 3 to 8 percent slopes.
Mansker clay loam, 0 to 1 percent slopes.
Mansker clay loam, 1 to 3 percent slopes.

This site accounts for about 31.3 percent of the total rangeland.

MIXED LAND SITE

This range site is level to gently sloping. The relationship between plants, soil, and moisture is good. If the range is in excellent condition, the growth on this site is little bluestem, side-oats grama, vine mesquite, and blue grama; there are no shrubs. If the site deteriorates to fair or poor condition, sand sagebrush, broom snakeweed, three-awn, sand dropseed, pricklypear, western ragweed, and annual grasses and forbs will invade. The soils in this site are—

Dalhart fine sandy loam, 0 to 1 percent slopes.
Dalhart fine sandy loam, 1 to 3 percent slopes.

This site occupies about 1 percent of the total rangeland.

MIXED LAND SLOPES SITE

This range site occurs on slopes below the two caliche sites. The relationship between plants, soil, and moisture is good to excellent. If this site is in excellent condition, the growth is side-oats grama, little bluestem, sand bluestem, New Mexico feathergrass, and Canada wildrye. Sand sagebrush, yucca, and other shrubs constitute no more than 5 percent of this site when it is in good to excellent condition. If the site deteriorates to fair or

Figure 7.—Typical vegetation on Bippus fine sandy loam; yucca plants are in bloom.

poor condition, sand sagebrush, yucca, sand dropseed, hairy grama, and three-awn will increase (fig. 7). These plants are not invaders. They increase from the few plants originally present. The soils in this site are—

Bippus fine sandy loam, 5 to 8 percent slopes.
Bippus fine sandy loam, 3 to 5 percent slopes.
Bippus fine sandy loam, 1 to 3 percent slopes.

This site covers about 11.2 percent of the total rangeland.

SANDHILLS SITE

This range site is hummocky or rolling. Generally, the relationship between plants, soil, and moisture is excellent. In some places, however, permeability is so rapid that plant nutrients have been leached from the root zone. If this site is in excellent condition, the growth is little bluestem, sand bluestem, switchgrass, Indiangrass, Canada wildrye, giant dropseed, and big sandreed. Side-oats grama, silver bluestem, hairy grama, three-awn, sand dropseed, sand sagebrush, yucca, sand plum, and skunkbrush constitute a small percentage of the plant cover. Sand sagebrush, yucca, and other shrubs make up no more than 10 percent of the total plant cover if the range is in excellent condition. If the site deteriorates to fair or poor condition, red lovegrass, annual forbs and grasses, Queen's delight, and western ragweed invade. Sand sagebrush, yucca, sand dropseed, and three-awn increase if the site deteriorates. The soils in this site are—

Likes loamy fine sand, 1 to 8 percent slopes.
Sandy alluvial land.
Vona loamy fine sand, 1 to 5 percent slopes.

This site covers about 3.6 percent of the total rangeland.

DRY BOTTOM-LAND SITE

This range site occurs along drainageways and adjacent to stream beds. Permeability of the soils varies from slow to moderately rapid. Because these soils are flooded occasionally, the relationship between plants, soil, and moisture is better than average. Consequently, these soils can support better pasture plants. If this site is in excellent condition, the growth is side-oats grama, little bluestem, sand bluestem, Indiangrass, switchgrass,

and Canada wildrye, with some silver bluestem, vine mesquite, and western wheatgrass. There are no shrubs. If the site deteriorates to fair or poor condition, three-awn, sand dropseed, mesquite, small soapweed, pricklypear, and western ragweed will invade. The soils in this site are—

Spur clay loam, high.
Spur clay loam, low.
Spur fine sandy loam, high.
Spur fine sandy loam, low.
Spur soils.

This site occupies about 5.7 percent of the total rangeland.

CALICHE SHALLOW LAND SITE

This range site is sloping to moderately steep. It occurs on the caprock. It differs from the Caliche breaks site because it has milder slopes, deeper soils, and greater productivity. The relationship of plants, soil, and moisture is fair to good. The soils in this site are calcareous and support a valuable type of vegetation. If this site is in excellent condition, the growth is side-oats grama, New Mexico feathergrass, little bluestem, sand bluestem, switchgrass, Canada wildrye, blue grama, hairy grama, silver bluestem, and small amounts of Indiangrass. Catclaw, yucca, redberry juniper, and other shrubs constitute not more than 5 percent of the total plant cover if the range is in excellent condition. If the site deteriorates to fair or poor condition, hairy tridens, pricklypear, and annual grasses and forbs invade. Blue grama, hairy grama, three-awn, sand dropseed, catclaw, yucca, and redberry juniper increase as the site deteriorates. The soils in this site are—

Mansker clay loam, 3 to 6 percent slopes.
Potter soils, 0 to 8 percent slopes.
Potter-Mansker soils, 0 to 8 percent slopes.

This site occupies about 10.4 percent of the total rangeland.

CALICHE BREAKS SITE

This range site is on steep slopes and broken land. It occurs on the caprock. It differs from Caliche shallow land site because it has steeper slopes and is not as deep and productive. The relationship between plants, soil, and moisture is fair to good. The soils in this site are calcareous. They support a valuable type of vegetation. If this site is in excellent condition, the growth is side-oats grama, little bluestem, New Mexico feathergrass, sand bluestem, Indiangrass, Canada wildrye, hairy grama, silver bluestem, and some switchgrass. Catclaw, yucca, redberry juniper, mountain-mahogany, skunkbrush, and similar shrubs constitute more than 10 percent of the total stand when the range is in excellent condition. If the site deteriorates to fair or poor condition, hairy tridens, Texas grama, broom snakeweed, and annual grasses and forbs invade. Hairy grama, three-awn, sand dropseed, and the various shrubs increase if the site deteriorates. The soils in this site are—

Potter soils, 8 to 30 percent slopes.
Stony rough land, Potter material.

This site occupies about 19.5 percent of the total rangeland.

Engineering Properties of Soils

To make the best use of the soil maps, engineers need to know the physical properties of the soil materials and the in-place condition of the soils. This report contains information that engineers can use to—

1. Make studies that will aid in the selection and development of industrial, business, residential, and recreational sites.
2. Make preliminary estimates of runoff and erosion for use in designing drainage structures, planning dams, planning land leveling for irrigation, and planning other structures for water and soil conservation.
3. Make preliminary evaluations of soil and ground conditions that will aid in the selection of highway and airport locations and in planning detailed soil surveys for the intended locations.
4. Locate sand and gravel for use in structures.
5. Correlate performance of engineering structures with soil mapping units and thus develop information that will be useful in designing and maintaining the structures.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps, reports, and aerial photographs for the purpose of making soil maps and reports that can be readily used by engineers.

The mapping and the descriptive reports are somewhat generalized, however, and should be used only in planning more detailed field surveys to determine the in-place condition of the soil at the site of the proposed engineering construction.

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, and aggregate—have special meanings in soil science. These terms are defined as follows:

Soil: The natural medium for the growth of land plants on the surface of the earth; composed of organic and mineral materials.

Clay: Mineral particles less than 0.002 millimeter in diameter. As a textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Silt: Small grains of mineral soil 0.05 to 0.002 millimeter in diameter. As a textural class, soil that is 85 percent or more silt and less than 12 percent clay.

Sand: Small fragments of rock or mineral, between 0.5 and 2.0 millimeters in diameter. Sizes of sand are designated thus: *Coarse sand*, 1.0 to 0.5 millimeter; *sand*, 0.5 to 0.25 millimeter; *fine sand*, 0.25 to 0.1 millimeter; very fine sand, 0.1 to 0.05 millimeter. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Aggregate: A cluster of primary soil particles held together by internal forces to form a clod or fragment.

Granular structure: Individual grains grouped into spherical aggregates with indistinct sides. Highly porous granules are commonly called crumbs.

Engineering Classification Systems

There are the two systems for classifying soils in general use among engineers. Most highway engineers use the system approved by the American Association of State Highway Officials (AASHO).[4] In this system, classification is based on the identification of soils, according to their texture and plasticity and their performance in highways. All soil materials are classified in seven principal groups. The groups range from A–1 (gravelly soils of high bearing capacity, the best soils for subgrades) to A–7 (clay soils having low strength when wet, the poorest soils for subgrades).

Some engineers prefer to use the Unified System of soil classification established by the Waterways Experiment Station, Corps of Engineers.[5] This system is based on identification of soils according to their texture and plasticity and their performance as engineering construction materials. Soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic.

Table 2 lists the Unified classification for the soils and the classification used by the American Association of State Highway Officials.

Summary of Engineering Properties

The properties of the soils that affect their use in engineering are summarized in tables 2, 3, and 4.

Table 2 gives profiles for the important soil types and, for each layer, estimates the Unified classification of the material and the classification used by the American Association of State Highway Officials. Also estimated are the grain size, the permeability, structure, available water, dispersion, and shrink-swell potential. In this table, the column titled "Available moisture" gives the estimated number of inches of water in each foot of soil, when the soil is at field capacity. Field capacity is the amount of water a soil will hold available for plants 2 or 3 days after a good irrigation or rain. The column titled "Permeability" indicates the rate at which moisture moves downward in the soil; the rate is expressed in inches per hour. The estimates in these two columns—Available moisture, and Permeability—are particularly significant in irrigation. The ratings in the column titled "Dispersion" indicate the extent to which soil structure breaks down when water is applied. An easily dispersed soil seals over and resists penetration of water, roots, and air, and it is readily eroded by wind or water. The ratings in the column, Shrink-swell potential, indicate the volume change; that is, the shrinking of the soil when it dries and swelling of the soil as it takes up moisture. Soils having a high shrink-swell potential, the Pullman and Randall, for example, are not suitable sites for concrete structures.

Table 3 provides, for the soil series or land types, estimates on their suitability for several kinds of engineering work. The estimates on winter grading, location of grade line, and suitability as source of topsoil and sand or gravel are probably of most interest to highway engineers. The estimates in the other columns are primarily for conservation engineers.

As indicated in this table, most of the soils in the county can be graded in winter, but the Pullman, Randall, and Zita soils are fine textured and hard to break up when frozen.

For most of the soils, the grade line can be at or near the surface but, if a road is to be built on the Pullman, Randall, and Zita soils, the grade line should be at or above the ground.

Drainage is no problem on most of the soils, but water moves rather slowly over the nearly level Pullman soils, and the Randall soils are in the bottoms of playas and have no surface drainage.

The Potter soils and Stony rough land are not suitable for irrigation, but most of the other soils that are level or nearly level can be irrigated. The Vona and Likes soils, however, are so permeable that they would be suitable only for sprinkler irrigation. At present, most of the irrigated land is on Pullman soils, which are very slowly permeable. See the section, Use and Management of Soils, where the soils are grouped for irrigated farming.

The last three columns in table 3 point out properties of the soils that affect their use for construction of farm ponds, canals, and terraces. The calcium carbonate horizon in some of these soils is moderately permeable but will seal satisfactorily for dams and canals.

In the Potter soils and Stony rough land, the calcium carbonate, or caliche, ranges from a few inches to several feet in thickness. This material ranges from soft to moderately hard, and blasting may be necessary if excavations are to be made in it. These deposits of calcium carbonate are used extensively as a base for flexible pavement.

Table 4 groups the soils of the county by texture of the surface layer and gives a brief description of each group. Drainage, content of gravel and caliche, depth to the water table, and depth to bedrock are mentioned.

Soils of the County

This section has two parts. The first explains the methods soil scientists use in making the soil survey. The second describes the soil series and mapping units in the county.

How Soil Surveys Are Made

The scientist who makes a soil survey examines the soils in the field, classifies them according to the facts that he observes, and draws their boundaries on an aerial photograph or other map.

FIELD STUDY.—The soil scientist bores or digs many holes, about 40 inches deep, to see what the soils are like. The holes are not spaced in a regular pattern; they are located according to the lay of the land. Normally, the borings are not more than a quarter of a mile apart, and in some areas they are much closer together. In most soils there are several distinct layers, called horizons, which collectively are known as the soil profile. Each layer is studied to see how it differs from others in the profile and to learn the things about the soil that influence its ability to support plant growth.

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[4] AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS. STANDARD SPECIFICATIONS FOR HIGHWAY MATERIALS AND METHODS OF SAMPLING AND TESTING. Ed. 7, 2 v., illus. 1955.

[5] WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS. THE UNIFIED SOIL CLASSIFICATION SYSTEM. Tech. Memo. 3–357. v. 1, 2, and 3. 1953.

Color is normally related to the amount of organic matter. The darker the surface soil, as a rule, the more organic matter it contains. Streaks and spots of gray, yellow, and brown in the lower layers generally indicate poor drainage and poor aeration. Lighter shades of color are caused by lime.

Texture, or the content of sand, silt, and clay, is determined by the way the soil feels when rubbed between the fingers, and it is later checked by laboratory analyses. Texture determines how well a soil retains moisture, plant nutrients, and fertilizer; to what degree it may crack during dry weather; and whether it is easy or difficult to cultivate.

Structure, which is the way the individual soil particles are arranged in larger aggregates and the amount of pore space between grains, gives clues to the ease or difficulty with which the soil is penetrated by plant roots and by moisture.

Consistence, or the tendency of the soil to crumble or to stick together, indicates whether it is easy or difficult to keep the soil open and porous under cultivation.

Other characteristics observed in the course of the field study and considered in classifying the soils include the following: The depth of the soil over compact layers; the content of organic matter; the depth of root penetration; the steepness and pattern of slopes; the degree of erosion; the nature of the underlying rocks or other material from which the soil has developed; and the acidity or alkalinity of the soil, as measured by chemical tests.

CLASSIFICATION.—On the basis of characteristics observed by the field survey team or determined by laboratory tests, soils are classified into types, phases, and series. The soil type is the basic classification unit. A soil type may consist of several phases. Soil types that are similar in most characteristics are placed in a soil series.

Soil type.—Soils that are similar in kind, thickness, and arrangement of soil layers and that have the same texture in the surface layer are classified as one soil type.

Soil series.—Two or more soil types that differ in texture of the surface layer but are otherwise similar in kind, thickness, and arrangement of layers, are normally designated as a soil series. In a given area, however, a soil series may be represented by only one soil type. The Likes series is an example of this. Each soil series is named for the place near which it was first mapped. An example is the Dalhart series, which was first recognized near Dalhart, Tex.

Soil phase.—Because of differences other than kind, thickness, and arrangement of layers, some soil types are divided into two or more phases. Differences in slope, degree of erosion, depth of the soil over the substratum, or type of drainage are examples of characteristics that suggest dividing a soil type into phases.

The soil phase (or the soil type if it has not been subdivided) is the unit shown on the soil map. It is the unit that has the narrowest range of characteristics. Use and management practices, therefore, can be specified for this unit more easily than for the soil series or yet broader groups that contain more variation.

Soil complex.—If two or more different kinds of soils are so intricately associated in small areas that it is not practical to show them separately on the soil map, they are mapped together as a soil complex. Potter-Mansker is a complex mapped in Hansford County.

Miscellaneous land types.—Areas that have little true soil, such as fresh stream deposits, stony areas, and severely gullied areas, are not classified by types and series but are identified by descriptive names. Sandy alluvial land, and Stony rough land, Potter material, are miscellaneous land types in Hansford County. Sandy alluvial land consists of sandy bottom land and varies widely in characteristics. Stony rough land has little or no soil material and is characterized mainly by steep topography and rocky surface soil.

Descriptions of Soils

This section provides detailed information about the soil series and mapping units in Hansford County. The approximate acreage and proportionate extent of the soils are given in table 5; their location is shown on the detailed soil map at the back of this report.

Most of the terms used in describing soils are taken from everyday language and are readily understood without specialized knowledge of soils. A few of the terms, and some symbols, need explanation.

Soil scientists frequently assign a symbol to each layer of soil they describe. These symbols have special meaning to soil scientists and allow them to compare soils more efficiently. Most readers need remember only that letter symbols beginning with "A" are for surface soil; those beginning with "B" are for subsoil; and those beginning with "C" are for substratum, or the parent material. The letter symbols are followed by various subscripts, one of which may have particular value for the general reader. The subscript "ca" indicates an accumulation of calcium carbonate, or caliche. The symbol indicates merely that there is an accumulation of carbonate, not the nature and extent of the accumulation.

The color of soils is described both in words and symbols; for example, "yellowish brown (10YR 5/4)." The symbol, called a Munsell notation, indicates color more precisely than is possible with words. These notations are useful mainly to soil scientists.

The structure of soils is described by a sequence of words indicating the distinctness, the size, and the shape of the aggregates. Thus, "weak, fine, blocky structure" indicates that the aggregates are weakly defined, fine (small) in size, and blocklike in shape.

Terms have been established to indicate the nature of the boundaries between layers in the soil. An *abrupt* boundary is less than 1 inch wide; a *clear* boundary, 1 to 2½ inches; a *gradual* boundary, 2½ to 5 inches; and a *diffuse* boundary, more than 5 inches wide. The shape of the boundary is indicated thus: *Smooth*, if it is nearly level; *wavy*, if it has pockets, or undulations, wider than they are deep; and *irregular* if it has pockets, or undulations, deeper than they are wide.

On the soil map, symbols show special soil conditions that cover less than 5 acres within an area of a named soil. These symbols are explained in the legend for the soil map.

The location of the soil profiles in the county is given by sections and blocks. These locations are based on surveys made when railroads, schools, and individuals acquired grants of land from the Government.

Table 2.—*Estimated physical properties of soil profiles*

Soil type	Horizon	Depth	Classification: Unified	Classification: AASHO	Percentage passing— No. 200 sieve	Percentage passing— No. 4 sieve	Permeability	Structure	Available moisture
		Inches					*Inches per hour*		*Inches per foot of soil*
Bippus fine sandy loam	A	0 to 10	SM	A-4	40	96	1.0 to 3.0	Granular	1.5
	AC	10 to 24	SC	A-4, A-6	60	94	1.0 to 2.0	Granular	1.8
	C	24 to 60+	ML	A-4	60	90	0.5 to 1.0	Subangular blocky.	1.4
Bippus clay loam	A	0 to 7	ML	A-4	85	97	1.0 to 1.5	Granular	1.8
	AC	7 to 60	ML	A-4	70	96	0.4 to 0.8	Granular	2.0
	C	60 to 70+	CL	A-4, A-6, A-7.	70	90	0.5 to 1.0	Subangular blocky.	1.2
Dalhart fine sandy loam[1]	A	0 to 10	SM	A-4	40	98	1.0 to 1.3	Granular	1.5
	B	10 to 42	CL	A-4, A-6, A-7.	55	98	0.5 to 1.0	Subangular blocky.	1.7
	C	42+	ML	A-4	60	85	0.5 to 1.0	Blocky	1.5
Dalhart sandy clay loam	A	0 to 8	ML	A-4	60	97	1.0 to 1.5	Granular	1.6
	B	8 to 34	CL	A-4, A-6, A-7.	60	97	0.5 to 0.8	Subangular blocky.	1.7
	C	34 to 48+	ML	A-4	50	85	0.5 to 0.8	(2)	1.5
Likes loamy fine sand	A	0 to 12	SM	A-4	45	98	2.0 to 2.5	Single grain (structureless).	1.2
	AC	12 to 42	SM	A-4	50	94	1.0 to 3.0	Granular	1.2
	C_{ca}	42 to 80+	SM	A-4	50	85	1.0 to 3.0	Chalky	.8
Mansker clay loam	A	0 to 16	CL	A-4, A-6, A-7.	75	95	0.5 to 1.0	Subangular blocky.	2.3
	C	16 to 60+	CL	A-4, A-6, A-7.	75	82	0.5 to 1.0	(2)	.8
Portales silty clay loam	A	0 to 24	CL	A-4, A-6, A-7.	85	98	1.0 to 1.5	Subangular blocky.	2.2
	C_{ca}	24 to 35	ML	A-4	85	90	0.5 to 1.0	Granular	1.6
	D_{ca}	35 to 53	CL	A-4, A-6, A-7.	85	88	0.5 to 1.0	Granular	1.8
Potter soils	A	0 to 10	ML	A-4	65	90	0.7 to 1.5	Granular	1.8
	C_{ca}	10 to 25	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Pullman silty clay loam	A	0 to 10	MH	A-7	85	99	0.5 to 1.0	Subangular blocky.	2.4
	B	10 to 40	CH	A-7	85	98	0.05 to 0.3	Blocky	2.1
	D_{ca}	40+	ML	A-4	80	90	0.5 to 1.0	(2)	1.7
Randall clay	A	0 to 40	CH	A-7	85	99	0.05 to 0.4	Blocky	2.2
	C	40 to 50+	CH	A-7	85	98	0.05 to 0.3	Massive (structureless).	2.2

Spur fine sandy loam	1	0 to 20	SM	A-4	42	98	1.0 to 3.0	Granular	1.5
	2	20 to 40	ML	A-4	60	96	0.5 to 1.0	Granular	1.7
	3	40 to 60	ML	A-4	60	96	0.5 to 1.0	Subangular blocky.	1.7
Spur clay loam	1	0 to 18	ML	A-4	80	98	1.0 to 1.5	Granular	2.4
	2	18 to 50+	CL	A-6, A-7	85	96	0.3 to 0.8	Granular	2.0
Vona loamy fine sand [3]	A	0 to 35	SM	A-4	45	96	2.0 to 5.0	Structureless.	0.8
	C_{ca}	35 to 45+	[2]	[2]	[2]	[2]	[2]	[2]	[2]
Zita silty clay loam	A	0 to 30	MH	A-7	85	99	0.5 to 1.0	Subangular blocky.	2.2
	C_{ca}	30 to 50+	CL	A-6, A-7	80	85	0.5 to 1.0	[2]	.8

[1] A buried "B" horizon of Pullman silty clay occurs in many places at depths of 10 to 48 inches.

[2] Caliche.

[3] A buried horizon of Potter soil is just above the C

TABLE 3.—*Soil features*

Soil series or land type	Grading in winter	Location of grade line	Use as source of—	
			Topsoil	Sand or gravel
Bippus	Suitable	At or near ground surface	Suitable	Not suitable
Dalhart	Suitable	At or near ground surface	Suitable	Not suitable
Likes	Suitable	At any elevation	Generally not suitable because of sand.	Not suitable
Mansker	Suitable	At or near ground surface	Suitable	Not suitable
Portales	Suitable	At or near ground surface	Suitable	Not suitable
Potter	Suitable	At or near ground surface	Generally not suitable; thin top layer might be used.	Not suitable
Potter-Mansker	Suitable	At any elevation	Generally not suitable	Not suitable
Pullman	Limited suitability; hard to handle if frozen.	At or above ground surface; blanket needed.	Suitable	Not suitable
Randall	Limited suitability; hard to handle if frozen.	Generally above ground surface; blanket needed.	Limited suitability; might be used but very slowly permeable.	Not suitable
Sandy alluvial land	Suitable	Generally above ground surface; blanket needed.	Generally not suitable	Local pockets are suitable
Spur	Suitable	At or near ground surface	Suitable	Not suitable
Stony rough land	Suitable	At any elevation	Not suitable	Not suitable
Vona	Suitable	At or near ground surface	Generally not suitable because of sand.	Not suitable
Zita	Limited suitability; hard to handle if frozen.	At or above ground surface	Suitable	Not suitable

[1] See subsection, Management of Irrigated Land, for names of soils normally used for irrigation.

affecting engineering

Drainage	Irrigation [1]	Farm ponds	Canals	Terracing
Good [2]	Suitable; bench leveling generally needed on slopes of 2 to 6 percent.	Suitable; permeable substrata; will seal.	Permeable substrata; will seal.	Suitable; mostly short slopes of 2 to 6 percent.
Good	Suitable; bench leveling needed on slopes above 0.7 percent.	Suitable; permeable substrata; will seal.	Permeable substrata; will seal.	Suitable.
Good	Not suitable; too sandy and sloping for cultivation.	Not suitable; permeable in all strata.	Permeable in all strata; suitable only if sealed.	Not suitable.
Good	Limited suitability; shallow soils make leveling a problem.	Suitable; calcium carbonate layer is permeable; will seal.	Calcium carbonate layer is permeable; will seal.	Suitable.
Good	Suitable; bench leveling needed on slopes above 0.7 percent.	Limited suitability; calcium carbonate layer is permeable but will seal.	Calcium carbonate layer is permeable.	Suitable.
Good	Not suitable; shallow, stony, steep.	Suitable; calcium carbonate layer is permeable; will seal.	Calcium carbonate layer is permeable; will seal.	Not suitable.
Good	Not suitable; steep and shallow, with complex slopes.	Suitable; calcium carbonate layer is permeable; will seal.	Calcium carbonate layer is permeable; will seal.	Generally not suitable.
Slow surface drainage on level areas.	Suitable	Suitable; calcium carbonate layer is permeable; will seal.	No special problems; suitable for canals.	Suitable; needs drainage system.
Poor; is in bottoms of playas.	Very limited suitability; very slowly permeable; subject to flooding.	Suitable; can be used for a dug pond that has no dam.	Not suitable	Not needed.
Poor to good	Not suitable	Not suitable; layers of sand or gravel in most places.	Permeable throughout	Not suitable.
Good	Suitable; field leveling generally needed.	Limited suitability; lenses of sand or gravel in places.	Lenses of sand or gravel in places.	Diversion terraces needed to protect soils from outside water.
Good	Not suitable	Limited suitability; may be difficult to provide cutoff trenches.	Construction and maintenance of terrace are difficult.	Not suitable.
Good	Not suitable; too sandy.	Limited suitability; permeable in all strata; suitable only between dunes.	Permeable in all strata; suitable only if sealed.	Not suitable.
Slow surface drainage on level areas.	Suitable; bench leveling needed on slopes above 0.7 percent.	Suitable; calcium carbonate layer is permeable; will seal.	Calcium carbonate layer is permeable; will seal.	Satisfactory.

[2]A soil that has *good* drainage is *well drained*.

TABLE 4.—*Selected soil characteristics significant in engineering*

Soil name	Brief description
Bippus fine sandy loam, 1 to 3 percent slopes. Bippus fine sandy loam, 3 to 5 percent slopes. Bippus fine sandy loam, 5 to 8 percent slopes.	Well-drained, youthful soils (mainly SC or SM) occurring mostly below rough breaks or caprock. Contain some small caliche pebbles. The pH is generally above 7.0. Depth to bedrock and to the water table is generally more than 10 feet.
Bippus clay loam, 1 to 3 percent slopes. Bippus clay loam, 3 to 8 percent slopes.	Well-drained, youthful soils (ML or CL) occurring mainly below rough breaks. The pH is generally above 7.0. Depth to bedrock and to the water table generally is more than 10 feet.
Dalhart fine sandy loam, 0 to 1 percent slopes. Dalhart fine sandy loam, 1 to 3 percent slopes.	Well-drained soils; 15 to 48 inches of eolian fine sandy loam over Pullman silty clay loam. Noncalcareous (pH 7.0) at the surface. At depths of 30 to 48 inches soils become calcareous. Depth to bedrock is generally more than 10 feet. The water table is not high.
Dalhart sandy clay loam, 0 to 1 percent slopes. Dalhart sandy clay loam, 1 to 3 percent slopes.	Well-drained, eolian, sandy clay soils (ML or CL) that are noncalcareous at the surface. At depths of 30 to 48 inches grade to soft caliche. The pH is about 7.0 at the surface. Depth to bedrock is more than 10 feet. The water table is not high.
Likes loamy fine sand, 1 to 8 percent slopes.	Deep, well-drained, permeable, coarse-textured soil (mainly SM at the surface). Noncalcareous at the surface but grades to strongly calcareous at depths of 21 to 30 inches, and to highly calcareous and chalky at depths of 40 to 60 inches. Depth to bedrock, if bedrock occurs, is more than 10 feet. The water table is not high.
Mansker clay loam, 0 to 1 percent slopes. Mansker clay loam, 1 to 3 percent slopes. Mansker clay loam, 3 to 6 percent slopes.	Well-drained, shallow, calcareous, fine-textured soils (mainly CL) that grade to less plastic caliche material at depths of 16 to 54 inches. The layer of calcium carbonate is normally less than 20 inches from the surface. Depth to bedrock, if bedrock occurs, is more than 10 feet. The water table is not high.
Portales silty clay loam, 0 to 1 percent slopes. Portales silty clay loam, 1 to 3 percent slopes.	Well-drained, shallow, calcareous, fine-textured soils (mainly CL) that grade to less plastic caliche material. The layer of calcium carbonate is normally 20 inches or more from the surface. Depth to bedrock, if bedrock occurs, is more than 10 feet. The water table is not high.
Potter soils, 0 to 8 percent slopes. Potter soils, 8 to 30 percent slopes.	Well-drained, very shallow, highly calcareous, fine-textured soils (mostly CL at depth of 10 inches). Soft to moderately hard caliche at depths of 10 to 25 inches. The water table is not high.
Potter-Mansker soils, 0 to 8 percent slopes.	Occurs between the Pullman soils and the Spur soils in places where there is no rough stony land or caprock. Has the characteristics of both Mansker and Potter soils.
Pullman silty clay loam, 0 to 1 percent slopes. Pullman silty clay loam, 1 to 3 percent slopes. Pullman silty clay loam, 1 to 3 percent slopes, eroded.	Deep, noncalcareous, well-drained, very slowly permeable, fine-textured soils (mainly MH in the surface soil and subsoil). The pH is about 6.5 at the surface, but the soils are calcareous at depths of 24 to 44 inches. Depth to bedrock, if bedrock occurs, is more than 10 feet. The water table is not high.
Randall clay.	Deep, fine-textured, very slowly permeable soil (mainly CH to depths of 40 inches or more). Generally occurs in the bottom of playas. The pH is about 6.5 throughout the profile. Soil is underlain by calcareous clay loam, which is at various depths, depending on the amount of material washed in from adjoining Pullman soils. Randall soil swells a good deal when wet and shrinks when it dries. Depth to bedrock, if bedrock occurs, is more than 10 feet. The water table is not high.
Sandy alluvial land.	Sandy and clayey alluvium recently deposited on flood plains. Material extremely variable.
Spur clay loam, high. Spur clay loam, low.	Deep, well-drained, moderately permeable, calcareous soils (mainly CL to depths of 50 inches or more). Soils normally are at or near the bottom of a creek channel. Soils are deposited by floods and, in places, contain small lenses of sand or caliche pebbles. Depth to bedrock, if bedrock occurs, is more than 10 feet. The water table generally is not high. The low phase is subject to flooding during heavy rains.
Spur fine sandy loam, high. Spur fine sandy loam, low.	Calcareous soils (mainly SM or SC at the surface and ML or CL at depths of 36 to 60 inches). Soils normally are in or near the bottom of a creek. Soils were deposited by floods and, in places, contain small lenses of sand or caliche pebbles. Depth to bedrock, if bedrock occurs, is more than 10 feet. The water table generally is not high. The low phase is subject to flooding during heavy rains.
Spur soils.	Soils (mainly SM or CL) occur between the lower edge of the Spur clay loams and Spur fine sandy loams and the creek channel. In places, soils contain lenses of sand and caliche pebbles that make piping a problem. Depth to bedrock, if bedrock occurs, is more than 10 feet. The water table is not high; normally, it is at or near the level of the channel bottom. Soils are subject to flooding during heavy rains.
Stony rough land, Potter material.	Steep, rocky, rough and broken areas that generally occur above the Potter soils and below the Bippus soils along creeks and canyons. Material is mainly soft to moderately hard caliche, but there are some small areas of hard caliche and chert. Material from this land is extensively used as a base for flexible pavements. Blasting is generally needed if material has been exposed to air and sun. The rocky layer ordinarily is 3 to 20 feet thick.

Soil name	Brief description
Vona loamy fine sand, 1 to 5 percent slopes.	Deep, permeable, noncalcareous, well-drained soil (mainly SM to depths of 2 to 6 feet). Soil appears to have been deposited over Potter soils. Soft to moderately hard caliche generally is 30 to 45 inches from the surface. Depth to bedrock, if bedrock occurs, is more than 10 feet. The water table is not high.
Zita silty clay loam, 0 to 1 percent slopes. Zita silty clay loam, 1 to 3 percent slopes.	Well-drained, moderately permeable soils of medium depth (mainly MH in the surface soil and subsoil). The pH is 6.6 to 7.3 at the surface. At depths of 16 to 38 inches, soils are calcareous, and, at depths of 24 to 48 inches, they are strongly calcareous. Soils generally are associated with the Pullman soils but are more susceptible to wind erosion and more permeable. Depth to bedrock, if bedrock occurs, is more than 10 feet. The water table is not high.

TABLE 5.—*Approximate acreage and proportionate extent of soils*

Soil	Acres	Percent
Bippus fine sandy loam, 1 to 3 percent slopes	4, 587	0. 8
Bippus fine sandy loam, 3 to 5 percent slopes	6, 341	1. 1
Bippus fine sandy loam, 5 to 8 percent slopes	13, 932	2. 4
Bippus clay loam, 1 to 3 percent slopes	9, 029	1. 6
Bippus clay loam, 3 to 8 percent slopes	9, 156	1. 6
Dalhart fine sandy loam, 0 to 1 percent slopes	1, 224	. 2
Dalhart fine sandy loam, 1 to 3 percent slopes	546	. 1
Dalhart sandy clay loam, 0 to 1 percent slopes	2, 036	. 3
Dalhart sandy clay loam, 1 to 3 percent slopes	1, 301	. 2
Likes loamy fine sand, 1 to 8 percent slopes	2, 216	. 4
Mansker clay loam, 0 to 1 percent slopes	16, 241	2. 8
Mansker clay loam, 1 to 3 percent slopes	30, 761	5. 3
Mansker clay loam, 3 to 6 percent slopes	5, 380	. 9
Portales silty clay loam, 0 to 1 percent slopes	20, 844	3. 6
Portales silty clay loam, 1 to 3 percent slopes	17, 645	3. 0
Potter soils, 0 to 8 percent slopes	26, 451	4. 6
Potter soils, 8 to 30 percent slopes	37, 467	6. 4
Potter-Mansker soils, 0 to 8 percent slopes	12, 605	2. 2
Pullman silty clay loam, 0 to 1 percent slopes	277, 118	47. 7
Pullman silty clay loam, 1 to 3 percent slopes	16, 553	2. 8
Pullman silty clay loam, 1 to 3 percent slopes, eroded	322	. 1
Randall clay	6, 867	1. 2
Sandy alluvial land	5, 652	1. 0
Spur clay loam, high	3, 863	. 7
Spur clay loam, low	2, 645	. 5
Spur fine sandy loam, high	2, 413	. 4
Spur fine sandy loam, low	417	. 1
Spur soils	5, 300	. 9
Stony rough land, Potter material	2, 247	. 4
Vona loamy fine sand, 1 to 5 percent slopes	542	. 1
Zita silty clay loam, 0 to 1 percent slopes	28, 599	4. 9
Zita silty clay loam, 1 to 3 percent slopes	10, 180	1. 7
Total	580, 480	100. 0

Bippus series

The Bippus series consists of grayish-brown, well-drained, youthful soils that have developed on alluvial fans in the valleys and on colluvial foot slopes. These soils generally occur between the High Plains escarpment and the nearly level alluvial flood plains below. The parent material was calcareous fine sandy loam and clay loam washed down from higher elevations. Rounded, hard concretions of calcium carbonate are scattered throughout the profile.

These soils are associated with the Likes, Spur, Mansker, and Potter soils. The Likes soils are more sandy; the Potter and Mansker soils are shallower and, in places, are more exposed to normal erosion; and the Spur soils are nearly level and closer to the streams.

Bippus fine sandy loam, 5 to 8 percent slopes (BbD).—This soil is on concave or plane slopes in the valleys along Coldwater Creek and along the lower part of Palo Duro Creek and its tributaries. Isolated bands occur along the upper part of Palo Duro Creek next to the High Plains escarpment. The parent material was a mixture of clays that washed from the material above the caprock and of sand that washed from the Ogallala formation below the caprock. The areas average about 60 acres in size.

This is a moderately open soil. Drainage is free, both internally and externally. During heavy rains the soil receives extra water from adjacent higher bluffs. The slightly sandy grayish-brown surface layer is about 10 inches thick. The lower layers become gradually finer textured and lighter colored with depth.

The native vegetation consists of mid grasses—side-oats grama and blue grama, with yucca and a scattering of tall grasses and sand sage.

This profile is typical of this mapping unit; it occurs half a mile northwest of a bridge crossing Palo Duro Creek, 100 feet south of State Highway No. 282, in section 137, block 45, H. & T.C. RR. survey.

A 0 to 10 inches, grayish-brown (10YR 5/2; 3/2) fine sandy loam; weak, fine, granular structure; friable; some small, hard, rounded concretions of calcium carbonate; many worm casts; slightly calcareous; gradual boundary.

AC 10 to 18 inches, brown (10YR 5/3; 3/3) sandy loam; weak, fine, granular and moderate, fine, subangular blocky structure; friable, slightly hard; some medium, hard concretions of calcium carbonate; numerous worm casts; strongly calcareous; gradual boundary.

C 18 to 60 inches +, pale-brown (10YR 6/3; 5/3) sandy clay loam; compound weak, coarse, prismatic and moderate, fine, subangular blocky structure; friable, slightly hard; numerous medium, hard concretions of calcium carbonate; worm casts fewer with depth; strongly calcareous.

Range in characteristics: The A horizon is 8 to 26 inches thick, and in many places it is strongly calcareous to the surface. The texture ranges from loam to sandy loam. In some places there are a very few hard concretions. In others the concretions are abundant throughout the solum or are concentrated in lenses or layers several inches thick. In a few places a layer of silty clay loam occurs at a depth of 10 inches or more.

Inclusions: Small areas of the associated Potter, Mansker, and Likes soils are included within this mapping unit. The Potter and Mansker soils are commonly on

the small knolls or ridges. In many places near Coldwater Creek this mapping unit grades diffusely into areas of Likes soils. In other areas there is a gradual transition to Bippus clay loam or to the less sloping units of Bippus fine sandy loam.

This soil is not suitable for cultivation. Because of its light texture and steep slopes, it is subject to both wind and water erosion.

This soil is in capability unit VIe–2 (D) for dryland farming. It is in the Mixed land slopes range site.

Bippus fine sandy loam, 3 to 5 percent slopes (BbC).—This soil has complex slopes or single concave slopes. It has a slightly finer textured A horizon and AC horizon than Bippus fine sandy loam, 5 to 8 percent slopes. Some inclusions have a surface soil of silt loam or loam. The AC horizon is 10 to 30 inches thick. It is predominantly heavy sandy clay loam, but it ranges from silty clay loam to fine sandy loam. The areas average about 40 acres in size. More spots of other Bippus soils but fewer patches of Potter, Mansker, and Likes soils are included in this soil than in Bippus fine sandy loam, 5 to 8 percent slopes.

Although this soil will not erode so easily as Bippus fine sandy loam, 5 to 8 percent slopes, it is, nevertheless, too erodible to be well suited to cultivation. It is well suited to permanent pasture.

This soil is in capability unit IVe–1 (D) for dryland farming and in capability unit IVe–1 (Ir) for irrigated farming. It is in the Mixed land slopes range site.

Bippus fine sandy loam, 1 to 3 percent slopes (BbB).—More of this soil is on the alluvial fans than on the colluvial slopes. Most areas are below areas of the more strongly sloping phases of Bippus fine sandy loam and above areas of Spur soils. The boundary between this mapping unit and the Spur soils is generally diffuse. The slope of this soil is predominantly about 2 percent. The areas average about 40 acres in size.

Up to 40 percent of the surface layer is silt. The AC horizon and the C horizon are finer textured; they are generally sandy clay, but in many places they contain layers or lenses of fine sand, loam, or clay loam. The hard concretions of calcium carbonate are more numerous but smaller than those in other Bippus soils.

This soil is best suited to permanent pasture because it is subject to wind and water erosion. However, if properly managed, it can be cultivated safely.

This soil is in capability unit IIIe–3 (D) for dryland farming and in capability unit IIIe–4 (Ir) for irrigated farming. It is in the Mixed land slopes range site.

Bippus clay loam, 1 to 3 percent slopes (BaB).—This soil developed from calcareous clay loam washed down from the High Plains. It occurs on single, plane slopes in long strips between the High Plains escarpment and the Spur soils on the flood plains. In many places the boundary between this soil and the Spur soils is indistinct. This soil also occurs along the smaller streams; it generally covers the entire valley and extends to the caprock on either side. The areas average about 40 acres in size.

Internal drainage and external drainage are both moderate. The native vegetation consists of buffalograss and blue grama. If the soil is overgrazed, a few scattered yucca appear.

The following profile was observed in the east-central part of section 105, block 45, H. & T.C. RR. survey, 200 yards west of the road.

A_{11} 0 to 7 inches, dark-brown (7.5YR 3/2; 2/2) clay loam; moderate, medium, granular and moderate, medium, subangular blocky structure; top inch has weak, fine, platy structure; friable, slightly hard; slightly calcareous; clear boundary.

A_{12} 7 to 16 inches, dark-brown (7.5YR 4/2; 3/2) clay loam; moderate, medium, prismatic; moderate, medium, granular; and moderate, medium, subangular blocky structure; friable, slightly hard; numerous worm casts; strongly calcareous; gradual wavy boundary.

AC 16 to 31 inches, brown (7.5YR 5/2; 4/2) clay loam; moderate, medium and coarse, subangular blocky structure; firm, hard; few, medium, soft concretions of calcium carbonate; worm casts common; very strongly calcareous; gradual wavy boundary.

C_{ca} 31 to 40 inches +, light-brown (7.5YR 6/4; 5/4) clay loam; weak, subangular blocky structure; crumbly and friable, very hard; strongly calcareous; contains some soft and hard segregated particles of calcium carbonate; this is a horizon of weak carbonate accumulation.

Range in characteristics: The A horizon is 10 to 20 inches thick. In some places it is noncalcareous. The surface soil ranges from dark grayish brown to dark brown in color and from silty clay loam to sandy clay loam in texture. In some places the depth to the C_{ca} horizon is more than 66 inches, and in other places this horizon is lacking. The most conspicuous variation is in the quantity of concretions of calcium carbonate. In some places there are only a few concretions, and in other places they are common.

Inclusions: The most common inclusions are areas of Spur clay loam. Small ridges of Bippus fine sandy loam occur as fans formed along small streams that flow from higher areas where the soils are sandy.

This soil is well suited to cultivation. It will produce good yields. It is moderately susceptible to water erosion, and it needs moderate treatment for protection.

This soil is in capability unit IIIe–2 (D) for dryland farming and in capability unit IIIe–3 (Ir) for irrigated farming. It is in the Hardland slopes range site.

Bippus clay loam, 3 to 8 percent slopes (BaC).—About half of this soil is on dissected areas having a complex combination of concave-convex slopes of 3 to 8 percent. The rest is on single, concave or convex slopes of 3 to 6 percent. The complex slopes are along the channels and banks of the smaller streams. In these areas there are many patches of Spur soils and knobs and ridges of Potter and Mansker soils that are too small to be mapped separately.

The solum is generally thinner than that of Bippus clay loam, 1 to 3 percent slopes. The A_{11} horizon is 3 to 8 inches thick. Generally, it is strongly calcareous. A few hard, small concretions of calcium carbonate occur in the A_{11} and A_{12} horizons. Concretions are common in the AC and C_{ca} horizons.

The areas average about 30 acres in size. A typical area of this soil is located 50 yards west and half a mile south of the northeastern corner of section 96, block 45, H. & T.C. RR. survey.

External drainage is rapid. Except for small areas on the smoother slopes, this mapping unit is not considered suitable for cultivation. The steeper slopes are highly susceptible to water erosion.

This soil is in capability unit VIe–1 (D) for dryland farming. It is in the Hardland slopes range site.

Dalhart series

The Dalhart series consists of reddish-brown to dark-brown, noncalcareous, well-drained soils that have a reddish-brown, friable, granular, moderately permeable subsoil. These soils developed from materials similar to the sandy clays in the substratum of the Pullman soils. They are in the west-central part of the county on ridges or slightly elevated areas. They are associated with the Pullman and Zita soils, but they are redder and more granular than the Pullman soils and, normally, are sandier than the Zita soils.

In some places the Dalhart soils are deeply developed and have a well defined C_{ca} horizon 30 to 40 inches below the surface. In other places they are shallow and have developed in a thin mantle of eolian material that was deposited on top of old, well-developed Pullman soils.

Dalhart sandy clay loam, 0 to 1 percent slopes (DbA).—This soil is in flats, on very low dunes, and in small areas on slopes near valley breaks. It formed in material that overlies older soils, such as the Pullman, Zita, and Portales. The slopes are plane or slightly convex.

About 30 percent of the soil material is clay. Internal and external drainage are medium. The native vegetation consists of short grasses, mainly buffalograss and blue grama. The areas average about 200 acres in size.

This profile was observed in a cultivated field near the southeastern corner of section 73, block 2, G.H. & H. RR. survey.

A 0 to 8 inches, grayish-brown (10YR 5/2; 3/2) sandy clay loam; moderate, medium, granular and weak, coarse, subangular blocky structure; very friable and soft; noncalcareous; few small pores; gradual boundary.

B_{21} 8 to 20 inches, brown (7.5YR 5/2; 4/2) heavy sandy clay loam; moderate, medium, subangular blocky and moderate, coarse, prismatic structure; friable and hard; noncalcareous; numerous small pores and worm casts; color is lighter when peds are crushed; clear boundary.

B_{22} 20 to 28 inches, reddish-brown (5YR 5/3; 4/3) sandy clay loam; moderate, medium, subangular blocky and moderate, coarse, prismatic structure; very friable; noncalcareous; clear boundary.

B_{ca} 28 to 34 inches, reddish-brown (5YR 5/3; 4/3) sandy clay loam; very friable; strongly calcareous; many hard and soft calcium carbonate concretions; clear boundary.

C_{ca} 34 to 40 inches +, white caliche.

Range in characteristics: The surface soil ranges from 7.5YR to 10YR in hue and from heavy fine sandy loam to light clay loam in texture. The texture is predominantly sandy clay loam. Where the soil grades to the Pullman soils, the B_{21} horizon, below a depth of 10 inches, has a compound blocky and granular structure and is slowly permeable. The soil buried under this soil is 20 inches to more than 4 feet thick and consists of unconforming layers.

Inclusions: In places this soil grades to Dalhart fine sandy loam, and near the Zita and Pullman soils it tapers down to depths of 10 inches or less. Only minor areas of the associated Dalhart, Zita, and Pullman soils are included in this mapping unit.

This soil is well suited to cultivation. It is better suited to row crops than to drilled crops but is moderately susceptible to wind erosion.

This soil is in capability unit IIIec–2 (D) for dryland farming and in capability unit IIe–1 (Ir) for irrigated farming. It is in the Hardland range site.

Dalhart sandy clay loam, 1 to 3 percent slopes (DbB).—This soil has a thinner solum but is otherwise similar to Dalhart sandy clay loam, 0 to 1 percent slopes. The depth to the C_{ca} horizon ranges from 28 to 36 inches. Slopes of 1.5 percent are dominant; the relief is slightly dunelike. Buried soils are not so common as in Dalhart sandy clay loam, 0 to 1 percent slopes. The areas having no buried soils are on gentle slopes along the breaks near the upper part of draws.

The areas average about 30 acres in size. A typical area is half a mile east and 100 yards south of the northwestern corner of section 221, block 2, G.H. & H. RR. survey.

This soil is well suited to crops, but use is somewhat limited by susceptibility to wind and water erosion. About half of the area is cultivated.

This soil is in capability unit IIIe–2 (D) for dryland farming and in capability unit IIIe–2 (Ir) for irrigated farming. It is in the Hardland range site.

Dalhart fine sandy loam, 0 to 1 percent slopes (DaA).—This soil lies east of where Coldwater Creek enters the county. It consists of a few areas of 300 acres or more and of several smaller areas nearby. The areas average about 50 acres in size.

Buried soils, where present, are at greater depths than in the Dalhart sandy clay loams, or 40 inches or more from the surface.

This soil is in native pasture; it is highly susceptible to wind erosion.

Profile description:

A_{1p} 0 to 6 inches, brown (10YR 5/3; 4/3) fine sandy loam; weak, fine, granular structure; very friable, soft; noncalcareous; abrupt boundary.

A_{12} 6 to 10 inches, dark-brown (10YR 4/3; 3/3) fine sandy loam; weak, fine, granular and coarse, prismatic structure; friable and slightly hard; noncalcareous; porous; clear boundary.

B_1 10 to 18 inches, brown (10YR 5/3; 4/3) sandy clay loam; compound structure; strong, fine, granular; moderate, coarse, prismatic; and weak, medium, subangular blocky; friable and hard; noncalcareous; gradual boundary.

B_2 18 to 42 inches, brown (10YR 4/3; 3/3) sandy clay; weak, medium, subangular blocky structure; firm, hard; slightly calcareous in upper part, strongly calcareous in lower part; very porous; many root channels; several soft calcium carbonate concretions; clear boundary.

D_{1b} 42 to 48 inches +, dark-brown (7.5YR 4/4; 3/3) clay; strong blocky structure; calcareous.

Range in characteristics: Where buried soils are absent, a C_{ca} horizon may be at a depth of about 20 inches, but more commonly it is at a depth of about 40 inches.

Inclusions: Small areas of Dalhart sandy clay loam are included.

This soil is best suited to pasture because it is subject to wind erosion. Under proper management, however, it can be cultivated safely.

This soil is in capability unit IIIe–3 (D) for dryland farming and in capability unit IIe–2 (Ir) for irrigated farming. It is in the Mixed land range site.

Dalhart fine sandy loam, 1 to 3 percent slopes (DaB).—In the western part of the county there are two areas of this soil measuring about 100 acres each, as well as

several smaller areas. This soil is more open and has better internal drainage and external drainage than Dalhart fine sandy loam, 0 to 1 percent slopes. The topography is dunelike. A typical area is 500 yards south of the northwestern corner of section 111, block 2, G.H. & H. RR. survey.

This soil is best suited to permanent pasture because it is highly susceptible to wind erosion. It can be cultivated if properly managed. Wind erosion can be controlled more easily if the soil is irrigated.

This soil is in capability unit IIIe–3 (D) for dryland farming and in capability unit IIIe–4 (Ir) for irrigated farming. It is in the Mixed land range site.

Likes series

The Likes series consists of dark grayish-brown, deep, youthful, calcareous, very sandy soils. The soils developed from sandy colluvial or eolian material lying below the caprock and along the major streams. They are closely associated with the Bippus soils, which are darker and contain more clay throughout the solum. They resemble the Vona soils, which occur only above the caprock.

Internal drainage is very rapid. The vegetation consists of sand sage, side-oats grama, yucca, and a mixture of tall grasses. The areas average about 60 acres in size.

Likes loamy fine sand, 1 to 8 percent slopes (LaC).—This profile was observed along the east-west quarter line on the eastern side of section 107, block 2, G.H. & H. RR. survey.

A_1 0 to 12 inches, dark grayish-brown (10YR 4/2; 3/2) loamy fine sand; single grained and loose; noncalcareous in upper 5 inches, slightly calcareous in lower part; gradual boundary.

AC 12 to 42 inches, brown (10YR 5/3; 3.5/3) loamy fine sand; single grained and loose; many hard and soft concretions of calcium carbonate; calcareous; gradual boundary.

C_{ca} 42 to 56 inches +, pale-brown (10YR 6/3; 4.5/3) loamy fine sand; single grained and loose; 50 percent of material, by volume, is hard concretions of calcium carbonate; strongly calcareous.

Range in characteristics: The texture of the surface soil ranges from heavy loamy fine sand to loamy sand, and, in places, this layer contains many hard concretions of calcium carbonate ranging up to 1 inch in diameter. The AC horizon ranges from light yellowish brown to dark brown. In places the C_{ca} horizon is a pinkish, chalky earth.

Inclusions: Many knobs and narrow ridges of Potter and Mansker soils are included. In many places Bippus fine sandy loam is also included. Generally, however, there is a broad line of transition between this soil and the Bippus soil.

Because this soil is open, highly susceptible to wind erosion, and strongly sloping, it is considered nonarable. It is used only as rangeland. If it were irrigated, it could be cultivated occasionally.

This soil is in capability unit VIe–3 (D) for dryland farming. It is in the Sandhills range site.

Mansker series

The Mansker series consists of brown to grayish-brown shallow soils that developed from strongly calcareous sediments. These soils generally are on the more sloping parts of the High Plains. They are associated with the Potter soils, which developed in associated beds of caliche; the Portales soils, which are slightly darker colored and deeper; and the Pullman and Zita soils, which are deeper and darker colored and have a noncalcareous surface soil.

The native vegetation consists of short grasses, principally grama and buffalograss. Most of this series is in native pasture. Some of the nearly level areas are cultivated.

Mansker clay loam, 1 to 3 percent slopes (MaB).—This soil, the most extensive in the Mansker series, is generally near the canyon and valley breaks, but in a few places it is on the rims of the deeper playas. Internal drainage and external drainage are both medium. The areas average about 35 acres in size.

This profile was observed in a pasture 500 yards south and 200 yards west of the northeastern corner of section 1, block 4T, T. & N.O. RR. survey.

A_1 0 to 5 inches, dark-brown (10YR 4/3; 3/3) clay loam; fine, subangular blocky structure; topmost 1½ inch has weak structure and is slightly compacted; weak surface crust; friable, slightly hard; many roots and worm casts; strongly calcareous; gradual boundary.

AC 5 to 13 inches, brown (10YR 5/3; 4/3) heavy clay loam; weak, fine, subangular blocky structure; friable, slightly hard; many worm casts; pores up to 2 millimeters in diameter are common; many faint threads and films of calcium carbonate and a few hard concretions of calcium carbonate; strongly calcareous; clear boundary.

C_{ca} 13 to 30 inches, light-brown to reddish-yellow (7.5YR 6.5/5; 6/5) clay loam; very weak subangular and angular blocky structure; friable; strongly calcareous; few worm casts; pores less than 1.0 millimeter in diameter are common; many soft concretions of calcium carbonate up to 15 millimeters in diameter; clear boundary.

B_b 30 to 50 inches, reddish-brown (5YR 5/4; 5/4) light clay; compound weak, fine, and medium blocky and prismatic structure; very hard; many soft and a few hard concretions of calcium carbonate up to 10 millimeters in diameter; few ferromanganese concretions about 3 millimeters in diameter.

Range in characteristics: The surface soil is very dark grayish brown (10YR 3/2) to pale brown (10YR 6/3); the AC horizon is yellowish brown (10YR 5/4) to reddish brown (5YR 4/5). The solum is 10 to 20 inches thick over the carbonate zone.

Inclusions: Many small spots of other Mansker soils, some small areas of Potter, Bippus, and Portales soils, and a few spots of Dalhart sandy clay loam are included in this mapping unit.

This soil is best suited to permanent grass, but it can be cultivated if it is properly protected from erosion.

This soil is in capability unit IVe–1 (D) for dryland farming and in capability unit IIIe–5 (Ir) for irrigated farming. It is in the Hardland slopes range site.

Mansker clay loam, 0 to 1 percent slopes (MaA).—This soil resembles Mansker clay loam, 1 to 3 percent slopes, but is slightly darker and has a slightly more developed solum. The AC horizon generally has compound structure—weak, subangular blocky and strong, medium, granular. The areas of this soil average about 40 acres in size.

The Portales soils are so closely associated with this soil that it is often difficult to separate the two. In a few places this soil and the Portales soils occur in a

complex pattern. Small areas of Pullman, Zita, and Bippus soils are also included.

This soil is most suitable as grassland because it is shallow and subject to erosion. It can be cultivated, and, if properly managed, moderate yields can be obtained.

This soil is in capability unit IVe–1 (D) for dryland farming and in capability unit IIIe–5 (Ir) for irrigated farming. It is in the Hardland slopes range site.

Mansker clay loam, 3 to 6 percent slopes (MaC).—This soil generally is shallower and slightly lighter colored in the surface layer, but it is otherwise similar to Mansker clay loam, 1 to 3 percent slopes. The C_{ca} horizon is rarely at a depth of more than 15 inches. In a few areas, caliche pebbles are scattered over the surface. About 70 percent of this mapping unit has plane or convex slopes and lies on the rims of the larger playas or on the edges of breaks that lead to stream channels. The rest has a complex arrangement of convex slopes and is in the valleys that are dissected by small drains.

Included with this soil are small areas of Bippus soils in the saddles and of Potter soils on the small ridges or knolls.

The areas of this Mansker soil average about 50 acres in size and occur as narrow bands above the escarpment. A typical area of this soil is 500 yards east and 500 yards north of the southwestern corner of section 32, block 45, H. & T.C. RR. survey.

This soil is not suited to cultivation. Most of the acreage that was previously cultivated is now planted to permanent grass.

This soil is in capability unit VIe–4 (D) for dryland farming. It is in the Caliche shallow land range site.

Portales series

The Portales series consists of grayish-brown, moderately deep, moderately permeable, crumbly and friable, calcareous soils of the High Plains (fig. 8). Below a depth of 20 inches, these soils have strongly developed layers in which calcium carbonate has accumulated. The

Figure 8.—**Profile of Portales silty clay loam.**

parent material was strongly calcareous and probably of eolian origin.

These soils occur with the Zita and Mansker soils above the escarpments along the major drainageways and with the Zita or Pullman soils on slight ridges or very low knolls rising from the nearly level plains.

Zita soils contrast with the Portales in being noncalcareous to depths of 6 to 8 inches or more and in having a stronger subangular structure throughout the profile. The Mansker soils are much like the Portales but are only 10 to 20 inches deep. The Portales soils somewhat resemble the Bippus soils, but the Bippus soils do not have strongly developed carbonate layers and are on foot slopes or alluvial fans in erosional valleys lying below the Mansker and Potter soils.

The Portales soils cover a fairly large acreage in the county. Many areas are cultivated and irrigated.

Portales silty clay loam, 0 to 1 percent slopes (PaA).—Most of this soil lies on broad interstream divides along tributaries of Palo Duro Creek. Isolated areas that lie above the escarpment are scattered throughout the county.

Most of the areas measuring several thousand acres or more have nearly level, single, plane slopes of about 0.5 percent. Smaller areas generally have slopes of less than 1 percent; these are single slopes, slightly convex in shape, or a complex arrangement of convex slopes.

The areas average about 30 acres in size. The following describes a profile in an area 600 yards east of the northwestern corner of section 67, block 4T, T. & N.O. RR. survey.

A_{1p} 0 to 6 inches, grayish-brown (10YR 5/2; 3/2) silty clay loam; compound weak granular and subangular blocky structure; moderately friable, slightly hard; strongly calcareous; clear abrupt boundary.

AC 6 to 21 inches, light-brown (7.5YR 6/4; 4/4) silty clay loam; compound structure—weak, medium, prismatic and strong, medium, granular; friable and slightly hard; strongly calcareous; many worm casts; layer appears very porous; gradual wavy boundary.

C_{ca} 21 to 35 inches, light-brown (7.5YR 6/4; 4/4) silty clay loam; moderate, medium, prismatic and weak, medium, granular structure; friable and slightly hard; strongly calcareous; about 30 percent of material, by volume, is soft concretions of calcium carbonate; gradual boundary.

D 35 to 46 inches, brown (7.5YR 5/4; 4/4) silty clay loam; moderate, fine, granular structure; very friable and soft; strongly calcareous; contains many very fine, soft specks of calcium carbonate.

Range in characteristics: The color of the A_{1p} horizon ranges from 7YR to 10YR in hue and from 3.5/2 to 5/3 in chroma and value. In a few areas the A_{1p} horizon is loam or clay loam. The combined depth of the A_{1p} and AC horizons ranges from 20 to 35 inches. In about 10 percent of the areas, the upper 4 to 6 inches of the A_{1p} horizon is noncalcareous. In most areas, however, the upper few inches of the surface soil is slightly to strongly calcareous. Approximately 50 percent of the areas do not have the distinct, chalky, or white, horizon that indicates an accumulation of calcium carbonate. Where the carbonate is lacking, the horizon immediately below the AC horizon is a remnant of a buried soil.

Inclusions: Small areas of Mansker and Zita soils and a few small areas of Pullman and Potter soils are included. The included areas of Mansker and Zita soils

are numerous, but they amount to less than 15 percent of the areas in which they occur.

This soil is well suited to crops, though its powdery surface soil is highly susceptible to wind erosion. Good yields can be obtained, especially under irrigation.

This soil is in capability unit IIIec–2 (D) for dryland farming and in capability unit IIe–2 (Ir) for irrigated farming. It is in the Hardland range site.

Portales silty clay loam, 1 to 3 percent slopes (PaB).—This soil is similar to Portales silty clay loam, 0 to 1 percent slopes, except that it has dominantly single slopes, convex in shape, that range from 1 to 2 percent. Approximately 10 percent of the area is on dunelike relief and has a complex arrangement of slopes, convex in shape and ranging from 1 to 3.5 percent in gradient.

This soil is more closely associated with the Mansker soils than Portales silty clay loam, 0 to 1 percent slopes, but is less closely associated with the Pullman soils.

The areas average about 35 acres in size. A typical area occurs 150 yards east and 400 yards north of the southwestern corner of section 202, block 2, G.H. & H. RR. survey.

This soil is also well suited to cultivation, but it needs more protection from water erosion than Portales silty clay loam, 0 to 1 percent slopes.

This soil is in capability unit IIIe–2 (D) for dryland farming and in capability unit IIIe–3 (Ir) for irrigated farming. It is in the Hardland range site.

Potter series

The Potter series consists of very shallow, calcareous, grayish-brown soils that overlie weakly indurated caliche. These soils lie immediately above, on, and below the caprock that borders the valleys. Their parent material was a thick bed of caliche or a mixture of caliche and fine earth. Potter soils are thinner and generally more sloping and lighter colored than the Mansker soils. Their surface soil is more developed and smoother than that of Stony rough land, Potter material.

Potter soils, 0 to 8 percent slopes (PbC).—The slopes of this mapping unit are either single or complex. The single slopes are plane and nearly level; the complex slopes are convex and undulating. Surface drainage is medium to very rapid.

The vegetation consists of short grasses and mid grasses, mostly blue grama and side-oats grama. There is some blue grama and buffalograss, and catclaw in a few places.

Profile description:

A_{11} 0 to 6 inches, grayish-brown (10YR 5/2; 3/2) loam or light sandy clay loam; weak granular structure; friable; strongly calcareous; contains many small particles of indurated caliche; gradual boundary.

A_{12} 6 to 10 inches, light grayish-brown clay loam; strongly calcareous; about 50 percent of material, by volume, consists of strongly indurated caliche fragments ranging up to 3 inches in diameter; abrupt boundary.

D_r 10 to 25 inches +, white caliche, mostly weakly indurated in the upper 3 to 6 inches, but soft in places.

Range in characteristics: The surface layer ranges from 3 to 12 inches in thickness. In places its texture is fine sandy loam. The caliche ranges from pinkish white to white and is soft to strongly indurated within short distances. The slopes are dominantly less than 5 percent.

Inclusions: Mansker and Bippus soils, some Portales soils, and many small areas of more strongly sloping Potter soils are included in this mapping unit.

The soils of this mapping unit are well suited to grazing. They are in capability unit VIe–4 (D) for dryland farming and in the Caliche shallow land range site.

Potter soils, 8 to 30 percent slopes (PbF).—This mapping unit consists of several Potter soils having mostly a loam texture. It occurs between Potter soils, 0 to 8 percent slopes, and Stony rough land, Potter material. The slopes are dominantly between 8 and 15 percent, though some range up to 30 percent.

Generally, the soils of this mapping unit are thinner over the caliche than Potter soils, 0 to 8 percent slopes. In places there are many indurated caliche fragments, the size of gravel, on the surface and in the thin surface layer. Caliche crops out in small patches on some of the steeper slopes.

The areas average about 90 acres in size. A typical area is 600 yards north and 250 yards west of the southeastern corner of section 84, block 2, G.H. & H. RR. survey.

Many small areas of smooth Potter soils and of Stony rough land, Potter material, are included in this mapping unit.

The soils of this mapping unit are well suited to grazing but need careful management. In places they have a desirable but sparse cover of vegetation.

This mapping unit is in capability unit VIIs–1 (D) for dryland farming. It is in the Caliche breaks range site.

Potter-Mansker complex

This complex consists of 50 percent Potter loam, 25 percent Mansker clay loam, 17 percent Bippus clay loam, and 8 percent Zita, Portales, and Pullman soils. It occurs on the upper edges of the valleys.

The soils in this complex are so intermingled that it is not practical to map them separately. They occur between the more nearly level Pullman soils and the lower lying Spur soils in areas where there is no caprock and well-defined soil boundaries are lacking.

The Potter soils of this complex generally are on the ridges and knolls; the Mansker soils are in the more nearly level areas; and the Bippus soils are in the saddles between the ridges. The parent material for each series within this complex is the same as that described for each series mapped by itself.

External drainage is very rapid, and internal drainage is medium. The vegetation consists mostly of short grasses, buffalograss, and blue grama. Side-oats grama, with a scattering of yucca and catclaw, predominates on the shallow soils. Some bluestems grow in the draws. At present these soils are suitable only as rangeland, but small patches of the more nearly level Mansker and Bippus soils can be cultivated.

The areas of this complex are large; they average about 100 acres or more in size. A typical area is about 9 miles southwest of Gruver in the central part of section 263, block 2, G.H. & H. RR. survey.

Potter-Mansker soils, 0 to 8 percent slopes (PcC).—This mapping unit consists mainly of Potter and Mansker soils and partly of Bippus and Zita soils, all in intermingled areas too small to be mapped separately. The

profiles vary because there are so many gradations from one series to another. Either Potter or Mansker soils are dominant in a given area, and in that area the one dominant occupies up to 80 percent of the total acreage. The Mansker soils in this mapping unit have a profile much like that described for the Mansker series, and the Potter soils, a profile much like that described for the Potter series.

The slopes of the soils in this mapping unit are generally complex and either convex or concave. The dominant slope range is 2 to 6 percent. There are many knolls, ridges, saddles, and draws.

Range in characteristics: The surface soil is generally dark brown (7.5YR 4/2, dry), but in the more shallow places it is lighter colored. The texture of the surface soil ranges from clay loam to fine sandy loam but is dominantly loam. Except for the Bippus and Zita soils, the surface layer is generally strongly calcareous. The depth to the layer in which calcium carbonate accumulates ranges from a few inches in the Potter soils to several feet in the Bippus soils.

This mapping unit is in capability unit VIe–4 (D) for dryland farming. It is in the Caliche shallow land range site.

Pullman series

This series consists of dark, deep, fine-textured soils of the High Plains. The subsoil is blocky and has developed from silty and clayey calcareous sediments. The parent material probably was fine-textured Rocky Mountain outwash that had been intensively reworked by the wind. Internal drainage is very slow.

The Pullman soils are associated with the Randall soils, which occur in playas; with the Zita soils, which are more friable and shallower; with the Portales soils, which are more friable and are calcareous to the surface; and with the Mansker soils, which are also calcareous to the surface, more friable, and much shallower to the C_{ca} horizon.

The native vegetation consists of short grasses, mainly buffalograss and blue grama. These Pullman soils are nearly all cultivated. They are highly productive. Some are used for irrigated farming.

Pullman silty clay loam, 0 to 1 percent slopes (PdA).—This soil is the most extensive in the county. All of it occurs on High Plains, where it is intermingled with soils of other series. The slopes are single and plane. In a few places they are broken by shallow depressions or by playas.

The following typical profile was observed 700 yards south and 50 yards east of the northwestern corner of section 41, block 4T, T. & N.O. RR. survey.

A_p 0 to 5 inches, brown (10YR 5/3; 3/3) silty clay loam; weak, fine, granular and subangular blocky structure; friable, slightly hard; noncalcareous; abrupt boundary.

B_{21} 5 to 17 inches, dark-brown (7.5YR 4/2; 3/2) clay; moderate, medium and fine, blocky structure; breaks readily to moderate, fine and very fine, irregular blocky structure when moist; firm, very hard; few to many pores less than 0.5 millimeter in diameter; noncalcareous; clear boundary.

B_{22} 17 to 28 inches, brown (7YR 4/2; 3/2) clay; moderate, medium, blocky structure; horizontal faces of the peds more pronounced than vertical faces; some macropeds almost resemble thick plates; firm, very hard; few to many pores less than 0.5 millimeter in diameter; calcareous; few small spots and splotches of calcium carbonate on ped surfaces in lower 3 inches; gradual boundary.

B_{ca} 28 to 39 inches, brown (7.5YR 5/3; 3.5/4) clay; weak, medium and fine, blocky structure with some irregular blocky and a tendency toward subangular blocky; firm, hard to very hard; few to common pores 0.5 to 0.75 millimeter in diameter; calcareous; many soft concretions of calcium carbonate about 1.5 millimeters in diameter; gradual boundary.

B_{2b1} 39 to 59 inches, reddish-brown (6YR 5/4; 4/4) silty clay; weak, medium and fine, blocky structure, with some subangular blocky; friable; ped surfaces and most of soil mass are calcareous; spots, splotches, and streaks of calcium carbonate are common, mostly between blocks and in the pores; some ped surfaces have darker colored streaks that apparently were formed by materials leached from horizons above; gradual boundary.

B_{2b2} 59 to 75 inches, yellowish-red (5YR 5/6; 4.5/6) clay; weak, coarse and medium, angular blocky structure; firm, very hard; thin, patchy, dark, shiny coatings on ped surfaces appear to be formed by manganese; soil mass slightly calcareous and has threads and films of calcium carbonate, as well as few small specks and spots of soft calcium carbonate; clear boundary.

C_{cab} 75 to 85 inches, pink (7.5YR 8/4; 7/4) strongly calcareous silty clay; friable; many soft and few hard concretions of calcium carbonate; by volume, approximately 30 to 50 percent of layer is calcium carbonate.

C_b 85 to 115 inches +, reddish-yellow (5YR 6/6; 6/6) clay loam; strongly calcareous; by volume, an estimated 15 to 20 percent of layer is calcium carbonate.

Range in characteristics: The surface soil is dominantly silty clay loam, though the range is from light clay or clay loam to sandy clay. The depth to the C_{ca} horizon ranges from 30 inches to 10 feet or more, but generally the depth is about 5 feet. Numerous krotovinas, or holes dug by burrowing animals, may occur in all horizons. In the northern part of the county, this soil, and other Pullman soils, may be dark gray, rather than dark brown, and the solum may be slightly more permeable. In this part of the county the boundary between Pullman soils and Richfield soils is diffuse. Hence, the Pullman soils in this area tend to have some of the characteristics of the Richfield soils, which are not mapped in this county.

Inclusions: Areas less than 3 acres in size of Zita, Randall, and Portales soils, as well as gently sloping areas of other Pullman soils, are generally included with this soil. The Randall inclusions typically are in small depressions, a foot or more deep and less than half an acre in size. The other included areas have the same topography as this soil. Within a given area of this soil, the included soils will not total more than 3 percent of the acreage.

This soil is well suited to crops or pasture. It is resistant to wind and water erosion. With sufficient rainfall for dryland farming, or under irrigation, good yields can be expected.

This soil is in capability unit IIIec–1 (D) for dryland farming and in capability unit IIs–1 (Ir) for irrigated farming. It is in the Hardland range site.

Pullman silty clay loam, 1 to 3 percent slopes (PdB).—This soil is similar to Pullman silty clay loam, 0 to 1 percent slopes, except that the solum is generally thinner. The depth to the B_{ca} horizon is about 20 to 25 inches. In places the B_{ca} horizon is absent. The depth to the C_{cab} horizon is generally about 36 inches, but the range is from 25 to 50 inches.

Approximately one half of the acreage has long slopes of 1.5 to 2 percent and is made up of areas 100 acres or more in size. The other half is made up of narrow strips surrounding playas. These strips average about 30 acres in size and have slopes of 2 to 3 percent.

A typical profile of this soil is along the east-west quarter line of section 4, block 3, S.A. & M.G. survey.

This mapping unit includes more of Zita and Portales soils than does Pullman silty clay loam, 0 to 1 percent slopes. Some areas of Mansker soils up to 5 acres in size are also included. The inclusions make up about 5 percent of the total area of this mapping unit.

This soil is well suited to crops. Most of it is cultivated. However, unless steps are taken to control runoff, water erosion is a hazard, especially on the long slopes.

This soil is in capability unit IIIe-1 (D) for dryland farming and in capability unit IIIe-1 (Ir) for irrigated farming. It is in the Hardland range site.

Pullman silty clay loam, 1 to 3 percent slopes, eroded (PdB2).—This soil is similar to other Pullman soils except that it has little or no A horizon. This horizon has been washed away by moderately severe erosion. The B horizon is now the plow layer.

The surface soil, generally a light-brown (7YR 5/4) light clay, grades abruptly to brown clay B_2 horizon. The depth to the C_{ca} horizon is generally 20 to 25 inches. This soil has single slopes of convex shape. It lies at the base of long slopes occupied by other Pullman soils.

The areas average about 15 acres in size and occur in the shape of a quarter moon around the playas. A typical profile of this soil is about 2 miles northwest of Gruver in the southeastern quarter of section 302, block 2, G.H. & H. RR. survey.

If this soil is cultivated, it needs protection from erosion caused by flow of large amounts of water from other soils.

This soil is in capability unit IIIe-1 (D) for dryland farming. It is in the Hardland range site.

Randall series

This series consists of gray to dark-gray clayey soils that have no clearly differentiated horizons. These soils occur in enclosed depressions or shallow intermittent lakes (playas) on the High Plains. It is not known whether the sinking of the land or the blowing out of surface layers has caused these playas, but the upper part of the solum appears to be of recent lacustrine origin.

The soils of this series are generally noncalcareous at the surface. After heavy rains they are flooded for extended periods, and they are generally not suited to cultivation.

The Randall soils are associated with the Pullman, Zita, and Mansker soils. Their heavy clay parent material has been washed down or blown over from the nearby, higher lying areas of these associated soils. One soil of the Randall series is mapped in this county.

Randall clay (Ra).—This soil occurs in circular or oval areas, a few acres to 400 acres in extent, that lie 2 to 30 feet below the surrounding plains. In some places the surface is barren, and in others there are thick stands of sedges and perennial weeds. If the intermittent lakes remain dry for several seasons, a grass cover similar to that on the surrounding soils will grow.

The profile that follows was observed in a shallow depression covering about 200 acres. This depression is 8 feet below the surrounding Pullman soils and lies 1 mile east of Spearman in section 68, block 4T, T. & N.O. RR. survey.

A 0 to 8 inches, dark grayish-brown (10YR 4/3; 3/1) clay; moderate, fine, blocky structure; peds extremely hard; material very sticky and plastic; noncalcareous; the topmost 2 inches is grayish-brown silty clay that was washed or blown from the surrounding Pullman silty clay loam; deep cracks form when the material dries; gradual boundary.

AC 8 to 40 inches, dark-gray (10YR 4/1; 3/1) clay; moderate, medium and coarse, blocky structure; very firm; indistinct slickensides; below 30 inches, a few faint mottles of grayish brown and brown; noncalcareous; gradual boundary.

C 40 to 50 inches +, dark grayish-brown (10YR 4/2; 3/2) light silty clay with few films and threads of calcium carbonate; soil mass is noncalcareous.

Range in characteristics: The surface soil is predominantly of clay texture, but in a few areas there are recent deposits of silt or loam texture that obscure the clay texture. Generally the solum is noncalcareous, but in some of the playas it is neutral to strongly calcareous.

Inclusions: Included with this soil are some terraces lying ½ to 1½ feet above the lakebed. The profile on these terraces resembles the profile on the lakebed. During extremely wet periods, these terraces are covered by water.

Most of this soil is not suitable for cultivation. Areas in the shallower lakes, or in lakebeds that no longer receive water, are cultivated occasionally. Yields are comparable to those produced on other arable soils. This soil is highly susceptible to wind erosion, especially if it is left bare in spring.

This soil is in capability unit VIw-1 (D) for dryland farming. It is in the Hardland range site.

Sandy alluvial land

This miscellaneous land type consists of areas of sandy alluvium, small areas of recent unconsolidated alluvium, and streambanks and narrow side slopes. During heavy rains, which come about two or three times a year, it is subject to severe flooding. Then, during droughts, it may be dry for several months.

This land type differs from Spur soils mainly because it has a more sandy texture, is not so uniform throughout the solum, and has a sandy land vegetation of tall grasses and sand sage. The vegetation of the Spur soils consists mainly of short and mid grasses. There is one mapping unit of this miscellaneous land type in the county.

Sandy alluvial land (Sa).—This mapping unit consists of sandy and clayey alluvium recently deposited on the flood plains along Coldwater Creek and the lower part of Palo Duro Creek. It occurs as narrow bands in and along entrenched channels and on the edges of the flood plains, which are only 200 to 300 yards wide.

No one profile can be called typical for this mapping unit. One profile was observed west of a bridge over Coldwater Creek in section 62, block 2, G.H. & H. RR. survey. Here, this land type is pale-brown loamy fine sand that contains thin strata of very pale brown fine sand. The underlying material is calcareous, stratified,

light-colored fine sandy loam and fine sand, with thin strata of grayish-brown clay loam in places.

Range in characteristics: In some places the surface layer is loamy fine sand, which may or may not be stratified. In other places the surface layer is a clay loam and may be several inches deep over sandy alluvium that contains strata or lenses of materials of various textures.

Inclusions: Many small areas of Spur soils are included, as well as Likes and Bippus soils on the streambanks. The included soils make up about 10 percent of the total area.

This land type is not suited to cultivation, but it can be very good for grazing. It is in capability unit VIe–3 (D) for dryland farming, and in the Sandhills range site.

Spur series

This series consists of deep, dark-brown, calcareous alluvial soils of the bottom lands. They occupy areas that were once flooded plains, but now they are seldom, if ever, overflowed (fig. 9). Their parent materials were washed from Pullman, Zita, and Potter soils.

***Figure 9.*—Broad valley of Spur soils.**

Soils of the Spur series differ from Sandy alluvial land in having a more uniform profile. They differ from Bippus soils in that their parent material was brought from some distance upstream. The parent material for the Bippus soils is from local sources and is more colluvial in origin.

Spur soils can be irrigated; a plentiful supply of water is at depths ranging from 25 to 100 feet.

Spur clay loam, high (Sb).—This soil is nearly level; the gradient is less than 1 percent and is toward the stream channel. The areas are on the flood plains of Coldwater Creek and Palo Duro Creek and their tributaries. They are seldom, if ever, flooded. The areas average about 70 acres in size and are long and narrow. The parent material, dominantly a clay loam, was carried downstream from areas lying above the caprock. Internal drainage and external drainage are both medium. The native vegetation consists of short grasses.

The following typical profile was observed in the southwestern corner of section 7, block 5T, T. & N.O. RR. survey.

A 0 to 18 inches, dark grayish-brown (10YR 4/2; 3/2) light clay loam; strong, very fine, granular structure; very friable, soft; strongly calcareous; gradual wavy boundary.

AC 18 to 34 inches, brown (10YR 5/3; 4/3) clay loam; moderate, medium, granular and weakly prismatic structure; friable, slightly hard; strongly calcareous; many worm casts and pores; the slight coating of calcium carbonate on the ped surfaces increases with depth; gradual wavy boundary.

C 34 to 50 inches +, light yellowish-brown (10YR 6/4; 5/4) clay loam; moderate, fine, granular structure; friable and slightly hard; in the upper 4 inches, 5 percent of layer is small, hard and soft concretions of calcium carbonate; number of concretions decreases with depth.

Range in characteristics: The surface soil ranges from silty clay loam to clay in texture but is dominantly of clay loam texture. Lenses of silt or very fine sand are common in some places. Many hard concretions of calcium carbonate are scattered throughout the AC and C layers. These concretions are so concentrated in some places that they look like a lens of caliche gravel.

Inclusions: In low places this soil includes a few small areas of Spur clay loam, low. In areas that border higher lying soils, areas of Bippus clay loam are included. These inclusions of Bippus or Spur soils do not exceed 5 percent of any given area. This soil is highly productive. Some of the large areas are cultivated.

This soil is in capability unit IIIec–1 (D) for dryland farming and in capability unit IIe–1 (Ir) for irrigated farming. It is in the Dry bottom-land range site.

Spur clay loam, low (Sc).—This nearly level soil is in low areas along drainageways and streams. Its profile resembles that of Spur clay loam, high. During heavy rains, which come two or three times a year, it is flooded. The areas average about 25 acres in size, though there are many areas on the bottom of the valleys that are 5 to 10 acres in size.

A typical area of this soil is in the north-central part of section 311, block 2, G.H. & H. RR. survey.

At present this soil is not suited to cultivation, because it is subject to flooding. It has potential value as cropland, but it needs the protection that can be achieved by controlling the water on the watershed. This soil has great value as rangeland.

This soil is in capability unit Vw–1 (D) for dryland farming and is in the Dry bottom-land range site.

Spur fine sandy loam, high (Sd).—This smooth, nearly level soil is on the flood plains of Coldwater Creek and Palo Duro Creek. Its position is similar to that of Spur clay loam, high. The parent material is a mixture of calcareous sand and clay that was washed down from above and below the caprock and deposited by streams. The areas average about 40 acres in size.

External and internal drainage are good. The soil is seldom flooded. The supply of moisture is suitable for good plant growth.

The native vegetation consists of a mixture of short, mid, and tall grasses. Yucca is scattered throughout. In places, especially in wet years, there are thick stands of annual weeds.

The following profile was observed 900 yards east and 600 yards north of the southwestern corner of section 104, block 45, H. & T.C. RR. survey.

A_{11} 0 to 12 inches, grayish-brown (10YR 5/2; 3/2) fine sandy loam; moderate, very fine, granular structure; very friable and soft; slightly calcareous; diffuse boundary.

A_{12} 12 to 20 inches, grayish-brown (10YR 5/2; 3/2) sandy clay loam; medium, very fine, granular and weak, medium, prismatic structure; very friable, slightly hard; slightly calcareous; diffuse boundary.

AC 20 to 36 inches, light brownish-gray (10YR 6/2; 4/2) fine sandy loam; moderate, very fine, granular structure; soft; strongly calcareous; many worm casts and fine pores; gradual boundary.

C 36 to 60 inches, pale-brown (10YR 6/3; 4/2) heavy sandy clay loam; moderate, very fine, granular and moderate, fine, subangular blocky structure; very friable, slightly hard; strongly calcareous; many worm casts, fine pores, and fine threads and films of calcium carbonate.

Range in characteristics: The surface soil ranges from fine sandy loam to heavy loamy sand. In some places the subsurface layers and substratum consist of uniform fine sandy loam to a depth of 4 feet, but in others the profile below the surface soil is made up of varied coarse-textured and fine-textured lenses and layers.

Inclusions: In some places this soil includes small dunes of Sandy alluvial land. It also includes small irregular, low-lying areas of Spur clay loam, low; and of Spur fine sandy loam, low. In the higher lying areas —the ridges and small knobs—it includes small areas of Bippus fine sandy loam.

This soil is sometimes cultivated. Yields are moderate. The soil is better for permanent grass than for cultivated crops, as it is highly susceptible to wind erosion.

This soil is in capability unit IIIe–3 (D) for dryland farming and in capability unit IIe–2 (Ir) for irrigated farming. It is in the Dry bottom-land range site.

Spur fine sandy loam, low (Se).—This soil is in long narrow strips along stream channels. Within short distances, it varies more in texture and has a greater variety of textural lenses than Spur clay loam, low. Its position along stream channels is similar to that of Spur clay loam, low.

This soil is flooded frequently, but internal and external drainage are good. The native vegetation consists mainly of tall grasses, and mixed with the grasses, annual and perennial weeds and a few stands of sand sage.

The areas of this soil average about 20 acres in size. A typical area is near the streambank at the northeastern corner of section 12, block 45, H. & T.C. RR. survey.

Range in characteristics: The texture of the surface soil ranges from loam to loamy fine sand but is predominantly fine sandy loam. The water table generally is at a depth of 10 feet or more, but during wet seasons the water table is at a depth of about 4 feet in some areas.

Inclusions: Many small areas of Spur clay loam, low; of Spur soils; and of sandy alluvium are included with this soil. These included soils do not account for more than 8 percent of the total area.

This soil is not suited to cultivation; it is subject to flooding. It is well suited to permanent pasture and has a high carrying capacity.

This soil is in capability unit Vw–1 (D) for dryland farming; it is in the Dry bottom-land range site.

Spur soils (Sf).—This mapping unit consists of fine-textured overflow soils of the bottom lands. It occurs as long narrow strips in and along the channels of the larger streams and their tributaries. Characteristic of this mapping unit are complex slopes of about 2 percent, which have been formed by recent changes in the location of the stream channels.

The profile is similar to that of Spur clay loam, high, except that the different layers vary a great deal in thickness. The surface layer ranges from 2 inches to 20 inches in depth. In many places there is a layer of recently deposited, dark grayish-brown silty clay loam or clay loam on the surface.

These soils occur near Sandy alluvial land but they are less sandy and less variable in texture throughout.

Internal drainage is generally slow to medium, and external drainage is medium to rapid. The native vegetation consists of short grasses and mid grasses.

The areas average about 30 acres in size. A typical area is near the southwestern corner of section 104, block 45, H. & T.C. RR. survey.

Many areas of Spur clay loam, low, 5 acres or less in size, are included. They occupy about 15 percent of the total area.

These soils are not suited to cultivation, because they are subject to floods and have complex slopes. They are highly productive as grassland.

These soils are in capability unit Vw–1 (D) for dryland farming. They are in the Dry bottom-land range site.

Stony rough land

This miscellaneous land consists of rough broken areas along draws and canyons. Outcrops of stonelike caliche, strata of chert, and large boulders are numerous. The land is not suited to grazing, because the slopes range from about 25 to 100 percent or more and the areas are very dissected.

There is little or no soil, but the sandy or silty geologic material on the side slopes supports a thin cover of sideoats grama, sand bluestem, little bluestem, Indiangrass, switchgrass, other grasses, and a scattering of redberry juniper. There is one mapping unit of Stony rough land in this county.

Stony rough land, Potter material (Sg).—This mapping unit consists of steep canyonlike areas. The average area is long, irregular, narrow, and about 40 acres in size. A typical area is in the northwest quarter of section 65, block 45, H. & T.C. RR. survey.

Inclusions: Small areas of Potter soils, Mansker clay loam, Bippus clay loam, Bippus fine sandy loam, and Likes loamy fine sand are included in this mapping unit. These included areas are on smoother topography and on the bottom of the draws. They are 5 acres or less in size and make up less than 10 percent of the total area of this mapping unit.

This land is not suitable for cultivation. It is of limited value for grazing because it is rough and rocky.

This land type is in capability unit VIIs–1 (D) and in the Caliche breaks range site.

Vona series

The Vona series consists of sandy, friable, brown or reddish-brown, permeable soils on the High Plains. These soils have developed from calcareous eolian sands. The sands were blown in from the nearby valley of Coldwater Creek and deposited in dunes and ridges on older soils—those of the Potter, Mansker, and Portales series.

The Vona soils are deeper, sandier, and of different parent material than the associated Potter, Mansker, and Portales soils. They resemble the Likes soils but occur above the caprock instead of in the valleys. They are more sandy than the associated Dalhart soils, have a more permeable subsoil, and have a more marked dune-like relief.

The vegetation on the Vona soils consists of sand sage, yucca, and a mixture of mid and tall grasses. Water moves freely in these soils.

Vona loamy fine sand, 1 to 5 percent slopes (VaB).—This soil is northwest of Gruver. There is one large area, and several smaller areas are nearby.

The following typical profile was observed on a sand dune 300 yards east and 100 yards south of the northwestern corner of section 110, block 2, G.H. & H. RR. survey.

A 0 to 5 inches, brown (10YR 4/3; 3/3) loamy fine sand; weak granular structure; very friable, soft; noncalcareous; clear boundary.

B_2 5 to 15 inches, brown (7.5YR 5/4; 4/4) fine sandy loam; many, faint, fine mottles of other shades of brown; weak subangular blocky and granular structure; friable, very hard; noncalcareous; gradual boundary.

B_3 15 to 32 inches, brown (7.5YR 5/4; 4/4) light fine sandy loam that becomes more sandy with depth; weak subangular blocky structure; strongly calcareous; gradual boundary.

C 32 to 60 inches +, light yellowish-brown (10YR 6/4; 4.5/4) loamy fine sand; structureless; strongly calcareous; contains a few, soft, fine particles, films, and threads of calcium carbonate; apparently this is a weak C_{ca} horizon.

Range in characteristics: The depth to the buried Potter, Mansker, Portales, or Dalhart soils ranges from 2 to 10 feet or more. Generally, the depth to a buried Portales soil is 8 feet. The color of the surface soil is 10YR 4/3 to 10YR 5/4. In places the surface layer is structureless, loose, and extends to a depth of 15 inches. In these places, at a depth of about 6 inches, the surface layer is reddish brown (5YR 5/4) with fine mottlings of brown. Slopes range up to 8 percent but are dominantly about 5 percent; they are undulating to billowy.

Inclusions: Areas of the associated Potter, Mansker, Portales, and Dalhart soils that occupy 5 acres or less are included with this soil. These areas are flat and occur between sand dunes; they occupy less than 5 percent of this mapping unit. A few small, wet spots less than 1 acre in size occur in depressions between the dunes.

This soil is not suited to dryland farming; it is highly susceptible to wind erosion and is low in natural fertility. If carefully managed and irrigated, it can be cultivated occasionally.

This soil is in capability unit VIe–3 (D) for dryland farming. It is in the Sandhills range site.

Zita series

The Zita series consists of dark-brown or dark grayish-brown soils on the High Plains. These soils are strongly granular; they have developed on highly calcareous, friable, chalky material. They have a neutral to alkaline surface soil, but at a depth of about 16 inches they are calcareous. The principal associated soils are the Mansker, which are shallower, calcareous throughout the solum, and dark brown instead of grayish brown; the Portales, which are calcareous throughout; and the Pullman, which are deeper and have heavier blocky subsoil.

These soils generally have plane or slightly concave or convex slopes. Internal drainage is generally slow to medium.

The native vegetation consists mainly of buffalograss and blue grama, with some side-oats grama and a little bluestem. These soils are highly productive and are generally cultivated.

Zita silty clay loam, 0 to 1 percent slopes (ZaA).—This soil is closely associated with the Pullman and Portales soils. For the most part, however, it occupies broad, nearly level areas. Some areas are slightly depressed or slightly elevated. Some areas cover 1,000 acres or more, but the areas average about 80 acres in size. The following profile was observed 100 yards south of the farm to market highway, in a cultivated field, in section 112, block 2, G.H. & H. RR. survey.

A_{1p} 0 to 8 inches, grayish-brown (10YR 5/2; 3/2) silty clay loam; moderate, medium, granular structure; friable; noncalcareous; organic stains or film on peds; gradual boundary.

A_{12} 8 to 16 inches, brown (10YR 4/3; 3/2) silty clay loam; layer slightly finer textured than the one above; moderate, medium, granular and subangular blocky structure; friable; noncalcareous; many worm casts; gradual boundary.

AC 16 to 38 inches, brown (10YR 5/3; 4/3) clay loam; compound structure—weak, fine, granular and moderate, medium, subangular blocky; sticky, friable; strongly calcareous; numerous soft and hard concretions of calcium carbonate in lower part; color in lower part is pale brown (10YR 6/3; 5/3); numerous pores; layer is more calcareous with increasing depth; diffused boundary.

C_{ca} 38 to 59 inches +, very pale brown (10YR 8/4) silty clay loam; 50 percent or more of layer, by volume, is soft and hard calcium carbonate concretions; this is the zone of carbonate accumulation.

Range in characteristics: In a few places this soil is mapped along narrow drainageways that receive runoff from adjacent, gently sloping areas of Pullman or Dalhart soils. In these places the depth to the C_{ca} horizon is 48 inches or more; the calcareous subsoil is below 24 inches; and a thin sandy layer may occur within the upper 12 to 15 inches.

Inclusions: Near major drainageways Portales silty clay loam is commonly included with this soil. It occurs in a complex pattern of small ridges or in oval areas that are at a slightly higher elevation. These inclusions rarely exceed 5 acres in size and do not occupy more than 15 percent of any area mapped as Zita silty clay loam, 0 to 1 percent slopes. The Mansker soils are also included, but to a lesser extent than the Portales soils. Small patches of Pullman soils are included; they do not exceed 5 percent of the total acreage of the area in which they occur.

This soil is highly productive and fertile. It is well suited to cultivation.

For dryland farming, this soil is in capability unit IIIec–1 (D) and for irrigated farming, it is in capability unit IIe–1 (Ir). It is in the Hardland range site.

Zita silty clay loam, 1 to 3 percent slopes (ZaB).—This soil is similar to Zita silty clay loam, 0 to 1 percent slopes, except that it has single, slightly convex slopes and generally a thinner solum. The A horizon ranges from 5 to 15 inches in thickness, but generally it is 10 to 12 inches thick. The depth to the C_{ca} horizon is normally 26 to 32 inches.

Compared with Zita silty clay loam, 0 to 1 percent slopes, this soil includes about the same proportion of Portales soils, less of Pullman, and slightly more of Mansker and Zita.

The areas average about 60 acres in size. A typical area is in the north-central part of section 94, block 4T, T. & N.O. RR. survey.

This soil is well suited to cultivation. Because of its slopes, special care must be taken to control erosion.

This soil is in capability unit IIIe–1 (D) for dryland farming and in capability unit IIIe–2 (Ir) for irrigated farming. It is in the Hardland range site.

Formation of Soils

Soil is the product of the forces of environment acting on soil materials deposited or accumulated by geologic processes. The characteristics of the soil at any given point are determined by the interaction of five major factors—climate, living organisms, parent material, topography, and time. In the following, the five factors of soil formation are discussed in relation to the soils of Hansford County.

Parent material.—Nearly all of the soils in Hansford County developed in unconsolidated, calcareous parent materials. Generally, these parent materials have a high content of slightly weathered minerals.

The parent material of the Pullman, Zita, Portales, and Mansker soils is thought to be loess, probably of Nebraskan or later age in Pleistocene [6] time. This material is calcareous and clayey or loamy.

The parent material of the Dalhart and Vona soils was eolian (windblown) sands of more recent origin than those from which the Pullman, Zita, Portales, and Mansker soils developed.

The parent material for the soils in the deeply incised valleys or canyons is sandy or loamy alluvium or pedisediments. Rock exposed in the valleys apparently is no older than the Ogallala formation, which formed from Rocky Mountain outwash.

Climate.—The climate of Hansford County is continental and warm temperate. The amount and distribution of precipitation have been the dominant climatic influences on development of the soils. The limited rainfall has allowed growth of a good grass cover, but water seldom percolates below the root zone of the native plants.

Vegetation.—The climax vegetation, consisting of both mid and short grasses, has contributed organic matter to the soils. The soils have been darkened by the accumulation of organic matter.

Relief.—The county is on a nearly level constructional plain. Variations in relief are small but are of considerable significance in soil formation. The many slightly depressed areas receive slightly more water than the surrounding areas. The greater supply of water in the depressed areas permits growth of more vegetation, which, in turn, contributes more organic matter to the soils. Also, because there is more water in the depressed areas, there is more downward leaching of carbonates.

The nearly level areas on the plain are very resistant to geological erosion, and in these areas the normal soils of the region have developed. In contrast, geological erosion is comparatively active in the deeply entrenched valleys and canyons, and development of the soils is retarded.

Time.—Time is necessary for climate, living organisms, and relief to act upon geologic material to form soil. The longer these factors act upon the original geologic material, the more it will be altered.

The soils in this county vary in development. Those on the nearly level constructional plain have had the longest time to develop, as shown by their well developed profiles. On this plain, the Dalhart and Vona soils are younger than the Pullman because they have developed in mantles overlying buried Pullman soils. The soils of the valleys and flood plains are much younger than those of the constructional plain, as is evidenced by their poorly developed profiles.

Processes of Soil Formation

In this county, the five major factors of soil formation interact in such a way that certain processes of soil development are evident.

Leaching of lime.—While soils are developing, free lime in the soil material is dissolved by water and carried downward from the upper layers. In this county, the amount of rainfall is limited and the lime, therefore, is not leached from the soil profile. The lime is carried down as far as the water penetrates and is there redeposited. In some of the soils mapped, the zone of lime accumulation, commonly called caliche, is strongly developed; in others it is weakly developed; and in some it is hard to detect in the field. Some of the strongly developed zones of caliche are fairly deep in the profile. They developed in an old buried soil and are genetically related to the buried soil.

The soils vary in the amount of lime remaining in the surface layer. The amount remaining depends on the amount of lime that was in the parent material, the amount of water percolating through the profile, and the rate at which erosion removes the surface layer.

Translocation of clay.—After free lime was removed from the soils, clay began to move downward in some of the soils. Clay films on the peds indicate that the finer clay particles have moved gradually from the surface soil to the subsoil. The effects of this process are noticeable in the Pullman soils; moderately noticeable in the Dalhart soils; slightly noticeable in the Vona and Zita soils; and not noticeable in the other soils of the county.

[6] FRY, JOHN C. and LEONARD, A. B. ECOLOGICAL INTERPRETATIONS OF PLIOCENE AND PLEISTOCENE STRATIGRAPHY IN THE GREAT PLAINS REGION. Amer. Jour. Sci. 255: 1–11. 1957.

Accumulation of organic matter.—The interaction of climate and vegetation is such that organic matter accumulates in the soils. The organic matter greatly influences the development of soil horizons.

Classification of Soils

The soil series of Hansford County have been classified by orders and great soil groups as follows:

- ZONAL ORDER:
  - Chestnut soils:
    - Dalhart
  - Reddish Chestnut soils:
    - Pullman
  - Brown soils:
    - Vona
- INTRAZONAL ORDER:
  - Calcisols:
    - Mansker
    - Portales
    - Zita (intergrading to Chestnut soils)
  - Grumusols:
    - Randall
- AZONAL ORDER:
  - Lithosols:
    - Potter
  - Alluvial soils:
    - Spur
  - Regosols:
    - Bippus (intergrading to Calcisols)
    - Likes (intergrading to Calcisols)

Major soil series are shown in typical locations in figure 10.

Zonal soils are considered the normal soils of a region. Climate and vegetation are the factors that have dominated in their formation.

The Dalhart and Pullman soils are normal, or zonal, soils of this region. They have distinct, genetically related horizons that reflect the dominant influences of climate and living organisms. The Vona soils are also classified as zonal soils, but their profiles show less clearly the dominant influences of climate and living organisms. They have genetically related horizons, but these horizons are faint.

Intrazonal soils reflect the dominant influences of relief and time, not climate and living organisms. The Mansker, Portales, Zita, and Randall soils are intrazonal soils. They have evident, genetically related A_1 and C_{ca} horizons, but no B horizons. Apparently the Mansker, Portales, and Zita soils are too young to have developed a B horizon, but, in time, a textural B horizon may develop.

Azonal soils are too young or too steep to have genetically related horizons. The Potter soils are very shallow over thick beds of genetically unrelated caliche. The only evidence of development is a weakly defined A_1 horizon. Spur soils consist of recent alluvium and, other than an A_1, lack genetic horizons. The Bippus and Likes soils are in recent material on slopes and, in stage of development, are similar to the Spur soils.

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Chemical and Mechanical Analyses

Chemical and mechanical analyses of profiles of four major soil types in Hansford County are shown in tables 6 and 7, respectively. Analyses were made by the Soil Survey Laboratory, Soil Conservation Service, Lincoln, Nebr.

General Nature of the Area

This section tells about the physiography and climate of the county; provides some information about population and public facilities; and comments on the growth and present status of agriculture.

Physiography, Relief, and Drainage

This county is in the High Plains section of the Great Plains province. The average elevation is 3,200 feet, and most of the land is gently sloping or nearly level. The general slope is toward the northeast.

The plain is cut by two main streams that flow northeastward. These two streams, Palo Duro Creek and Coldwater Creek, are in deep valleys, several miles in width. Their stream channels are deeply entrenched in the broad valley floors. Palo Duro Creek has continuous flow only in the lower few miles. Coldwater Creek, and most of Palo Duro Creek, is dry for part of the year. When these creeks and their tributaries are flooded by torrential rains, silt is deposited along the channels.

Climate

Hansford County has a continental climate characterized by low humidity and wide ranges in daily and annual temperature. Limited and unpredictable rainfall restricts agriculture in the county. The most successful farmers are those who conserve moisture by the various methods discussed in the section, Use and Management of Soils.

Summer days are warm, but wind and low humidity keep them from being uncomfortable. Nights are cool and pleasant. The winters are mild enough for outdoor work. There are a few cold spells, lasting several days, during which the night temperature drops to near zero. These cold spells come quickly. Cold fronts from the northern Rocky Mountains and Northern Plains States sweep across the level prairie of this county at speeds up to 40 miles an hour. The temperature may drop 50 to 60 degrees within a 12-hour period.

The average annual precipitation (table 8) is about 22 inches, but the range is wide, or from about 8 inches, in 1930, to 36 inches in 1950. Records on average precipitation do not indicate the effect of the climate on crops. In some years precipitation is low, but yields are good because the moisture came when the crops needed it. In contrast, there are seasons that have droughts lasting several months. On the average, 60 percent of the total precipitation falls in the period May 1 to September 30. This average, however, does not indicate the frequent droughts, nor the fact that much of the summer rainfall comes as thunderstorms. During these storms, much of the water runs off the fields.

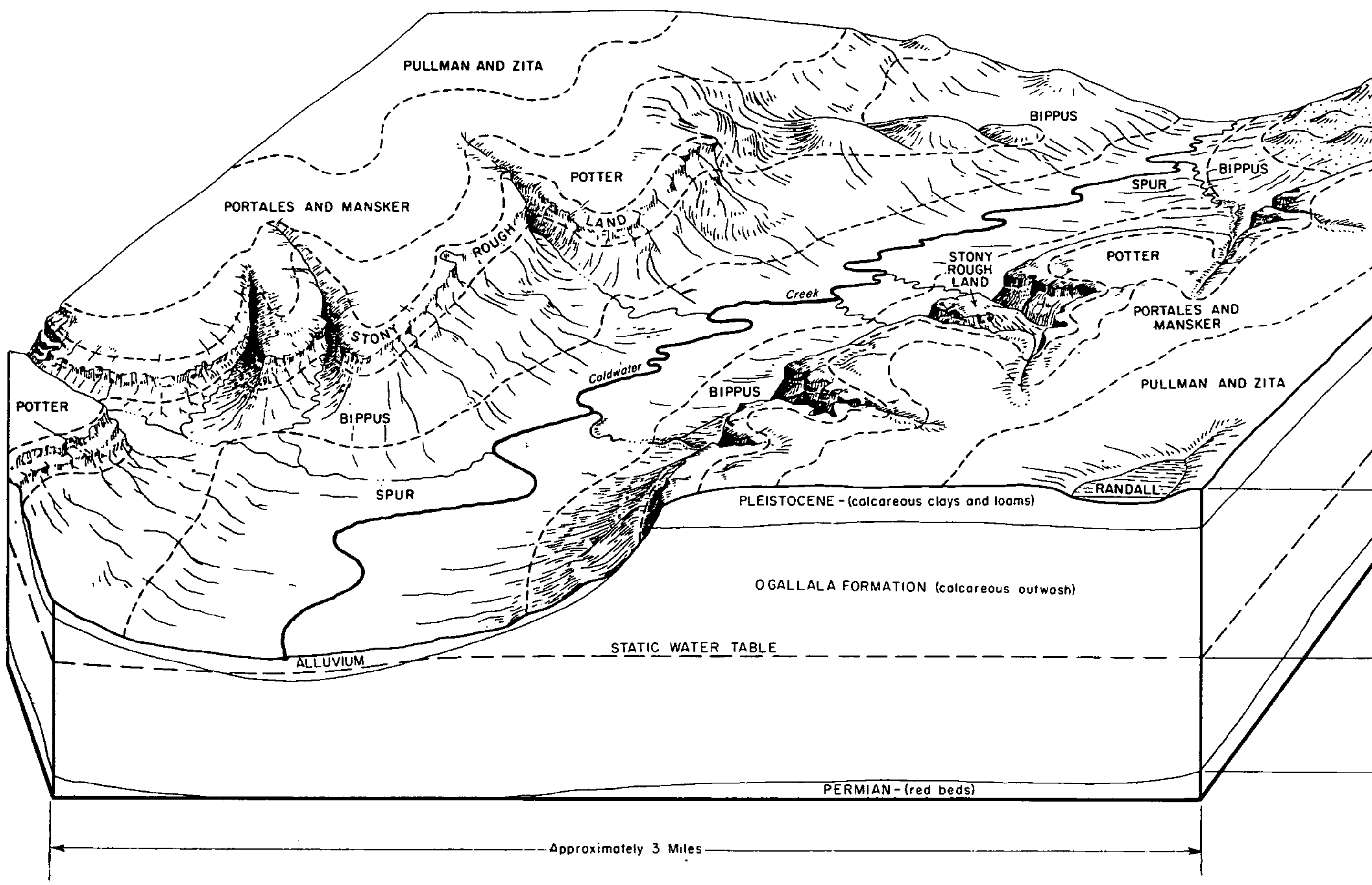


Figure 10.—**Diagram showing typical locations of soil series and the underlying parent material.**

TABLE 6.—*Chemical properties of profiles of four soil types*

[Analyses by Soil Survey Laboratory, Soil Conservation Service, Lincoln, Nebr. Dashed lines indicate analyses were not made or figu

Soil and horizon symbol	Depth	pH (1:1 ratio)	Organic carbon	Nitrogen	Calcium carbonate equivalent	Electrical conductivity (EC x 10^3)	Cation exchange capacity	Extractable cations					Exchangeable sodium percentag
								Ca	Mg	H	Na	K	
	Inches		*Percent*	*Percent*	*Percent*	*Millimhos per cm at 25° C.*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	*Me./100 gm. of soil*	
Mansker clay loam:													
A_{11}	0–4	8. 0	1. 75	0. 151	8	0. 6	14. 5	----	----	----	----	0. 8	----
A_{12}	4–9	7. 9	1. 24	. 132	23	. 7	13. 0	----	----	----	----	. 5	----
C_{ca1}	9–15	8. 1	. 98	. 103	42	. 6	11. 8	----	----	----	----	. 3	----
C_{ca2}	15–20	8. 3	. 53	. 055	48	. 6	9. 9	----	----	----	0. 1	. 3	1
$B_{21b?}$ or C	20–30	8. 4	. 13	. 019	39	. 7	11. 0	----	----	----	. 2	. 4	1
$B_{22b?}$ or C	30–48	8. 4	. 05	----	30	. 7	13. 4	----	----	----	1. 0	. 5	6
Portales silty clay loam:													
A_{1p}	0–5	8. 0	1. 28	. 132	3	. 7	21. 1	----	----	----	----	1. 4	----
A_{12}	5–13	8. 1	1. 04	. 112	9	. 6	20. 4	----	----	----	----	. 7	----
AC	13–24	8. 2	. 69	. 082	25	. 8	15. 5	----	----	----	----	. 5	----
C_{ca1}	24–35	8. 2	. 23	----	33	1. 2	11. 3	----	----	----	. 1	. 5	1
C_{ca2}	35–60	8. 6	. 09	----	53	. 6	7. 0	----	----	----	. 2	. 4	1
Pullman silty clay loam:													
A_p	0–5	6. 2	1. 21	. 114	----	. 8	19. 2	12. 4	3. 4	5. 5	----	1. 7	----
B_{21}	5–9	6. 2	1. 02	. 099	----	. 5	25. 5	17. 9	5. 1	5. 6	. 1	1. 3	----
B_{22}	9–17	7. 2	. 71	. 073	1	. 8	30. 6	23. 2	6. 8	3. 6	. 3	1. 2	1
B_{23}	17–28	8. 1	. 41	. 045	4	. 9	26. 4	----	----	----	. 6	1. 2	2
B_{ca}	28–39	8. 0	. 35	----	3	. 9	26. 6	----	----	----	1. 0	1. 3	3
B_{2b1}	39–50	8. 1	. 33	----	2	. 9	26. 1	----	----	----	1. 3	1. 2	4
B_{2b2}	50–59	8. 0	. 28	----	3	1. 5	22. 2	----	----	----	1. 2	1. 1	4
B_{2b3}	59–75	7. 9	. 22	----	2	1. 7	22. 8	----	----	----	1. 2	1. 1	4
C_{cab}	75–85	7. 9	. 14	----	45	2. 6	11. 6	----	----	----	. 7	. 5	2
Zita silty clay loam:													
A_{1p}	0–6	7. 6	1. 08	. 104	----	. 5	19. 5	17. 3	1. 5	2. 0	----	1. 4	----
A_{12}	6–15	7. 7	. 82	. 090	----	. 7	26. 0	25. 4	5. 6	2. 8	----	. 8	----
AC	15–21	8. 1	. 44	. 041	15	. 8	20. 3	----	----	----	. 1	. 6	----
C_{ca1}	21–30	8. 3	. 33	. 056	14	. 8	19. 4	----	----	----	. 2	. 7	1
C_{ca2}	30–40	8. 4	. 29	----	9	. 7	22. 2	----	----	----	. 6	1. 0	2
B_{2b1}	40–52	8. 4	. 22	----	3	. 7	21. 6	----	----	----	1. 2	1. 1	5
B_{2b2}	52–65	8. 1	. 19	----	2	1. 2	23. 4	----	----	----	1. 6	1. 0	5
C_{cab}	65–79	7. 9	. 13	----	45	3. 2	12. 6	----	----	----	1. 1	. 4	4

TABLE 7.—*Mechanical analyses of profiles of four soil types*

[Analyses by Soil Survey Laboratory, Soil Conservation Service, Lincoln, Nebr. See footnotes for explanation of letter symbols, in pare
in some columns]

Soil and horizon symbol	Depth	Particle size distribution (in millimeters)							
		Very coarse sand (2.0–1.0)	Coarse sand (1.0–0.5)	Medium sand (0.5–0.25)	Fine sand (0.25–0.10)	Very fine sand (0.10–0.05)	Silt (0.05–0.002)	Clay (less than 0.002)	II[1] (0.2–0.
Mansker clay loam:[2]	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percen*
A_{11}	0–4	0.9(a)	2.0(a)	3.8(b)	11.7(b)	14.4(b)	44. 6	22. 6	53
A_{12}	4–9	1.2(a)	2.1(a)	4.4(b)	11.3(b)	13.3(b)	36. 5	31. 2	44
C_{ca1}	9–15	.4(a)	1.2(a)	2.4(b)	7.1(b)	9.7(b)	34. 8	44. 4	31
C_{ca2}	15–20	.2(a)	.7(a)	1.6(b)	5.1(b)	8.6(b)	35. 2	48. 6	24
$B_{21b?}$ or C	20–30	.3(a)	.7(a)	1.8(b)	6.3(b)	12.8(b)	34. 2	43. 9	31
$B_{22b?}$ or C	30–48	.5(a)	1.2(a)	2.7(b)	8.4(b)	14.3(b)	35. 3	37. 6	36
Portales silty clay loam:[4]									
A_{1p}	0–5	.1(a)	1.0(b)	1.5(b)	5.6(b)	13.1(b)	56. 1	22. 6	56
A_{12}	5–13	----------	.8(c)	1.4(c)	4.7(c)	9.5(c)	53. 0	30. 6	48
AC_{ca}	13–24	.3(d)	1.8(d)	2.2(c)	6.8(c)	9.2(c)	44. 9	34. 8	38
C_{ca1}	24–35	.6(d)	2.7(d)	3.6(c)	11.6(c)	11.2(c)	36. 7	33. 6	30
C_{ca2}	35–60	1.4(d)	2.0(d)	3.2(c)	12.6(c)	10.2(c)	46. 3	24. 3	23
Pullman silty clay loam:[5]									
A_p	0–5	----------	.2	.5	3.1(a)	12.8(a)	56. 0	27. 4	52
B_{21}	5–9	----------	.1	.4	2.7(a)	9.7(a)	48. 5	38. 6	42
B_{22}	9–17	----------	.1	.4	1.9(a)	7.9(a)	37. 2	52. 5	36
B_{23}	17–28	----------	.1	.3	1.4(a)	6.4(a)	50. 4	41. 4	35
B_{ca}	28–39	----------	.3	.2	1.2(a)	6.0(a)	52. 2	40. 1	35
B_{2b1}	39–50	.1(b)	.4(b)	.2(b)	1.1(ab)	6.2(ab)	52. 6	39. 4	35
B_{2b2}	50–59	.4(b)	.3(b)	.3(b)	1.6(ab)	8.2(ab)	51. 3	37. 9	38
B_{2b3}	59–75	.3(b)	.2(b)	.3(b)	1.7(ab)	10.1(ab)	47. 9	39. 5	40
C_{cab}	75–85	.7(b)	.6(b)	.6(b)	3.0(ab)	10.1(ab)	43. 4	41. 6	29
C_b	85–115	.4(b)	.3(b)	.3(b)	2.6(ab)	13.1(ab)	44. 8	38. 5	38
Zita silty clay loam:[6]									
A_{1p}	0–6	.1(a)	.3(a)	.5(a)	2.9(a)	12.4(a)	59. 2	24. 6	56
A_{12}	6–15	.1(a)	.1(a)	.3(a)	2.5(a)	9.5(a)	52. 3	35. 2	46
AC	15–21	.1(c)	.2(c)	.6(b)	6.3(b)	14.0(b)	40. 7	38. 1	40
C_{ca1}	21–30	.3(c)	.4(c)	.5(b)	5.4(b)	18.8(b)	38. 6	36. 0	44
C_{ca2}	30–40	.4(d)	.6(d)	.8(b)	4.1(b)	11.5(b)	44. 0	38. 6	39
B_{2b1}	40–52	.2(d)	.4(d)	.4(b)	2.1(b)	9.2(b)	49. 2	38. 5	39
B_{2b2}	52–65	.2(d)	.1(d)	.2(b)	1.7(b)	10.1(b)	48. 1	39. 6	41
C_{cab}	65–79	.5(d)	.6(d)	.6(c)	3.4(c)	9.3(c)	43. 7	41. 9	27

[1] Size of selected separates by International scheme.
[2] Mansker: (*a*) concretions of calcium carbonate are many; (*b*) concretions of calcium carbonate are few.
[3] Trace.
[4] Portales: (*a*) contains organic matter; (*b*) smooth, black concretions, probably iron and manganese, are few; (*c*) concretions of calcium carbonate are few; (*d*) concretions of calcium carbonate are many.
[5] Pullman: (*a*) concretions, probably iron and man
tions of calcium carbonate are common.
[6] Zita: (*a*) smooth, black concretions, probably iro
(*b*) concretions of calcium carbonate are common; and
probably iron and manganese, are few; (*c*) concretio
common; (*d*) concretions of calcium carbonate are ma

TABLE 8.—*Temperature and precipitation at Spearman, Hansford County, Texas*

[Elevation, 3,250 feet]

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1930)	Wettest year (1950)	Average snowfall
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	36.6	87	−13	0.74	0.30	0.00	3.2
January	34.0	83	−13	.63	.25	.00	3.2
February	38.8	85	−13	.76	.00	.40	4.0
Winter	36.5	87	−13	2.13	.55	.40	10.4
March	46.1	93	−12	1.37	1.17	.20	3.8
April	55.5	95	10	2.02	.44	1.55	1.1
May	64.2	105	26	3.22	.66	2.67	(3)
Spring	55.3	105	−12	6.61	2.27	4.42	4.9
June	74.3	108	41	3.30	.88	6.33	0
July	80.2	110	50	2.20	1.60	11.14	0
August	78.9	109	47	2.38	.20	8.24	(3)
Summer	77.8	110	41	7.88	2.68	25.71	(3)
September	70.9	106	33	2.00	1.55	5.15	0
October	59.4	97	21	1.67	.87	.58	.1
November	45.0	87	0	.97	.12	.12	1.2
Fall	58.4	106	0	4.64	2.54	5.85	1.3
Year	57.0	110	−13	21.26	8.04	36.38	16.6

[1] Average temperature based on a 43-year record, through 1955; highest and lowest temperatures, on a 27-year record, through 1955.

[2] Average precipitation based on a 34-year record, through 1955; wettest and driest years based on a 35-year record, in the period 1921–55; snowfall based on a 35-year record, through 1955.

[3] Trace.

Hailstorms normally are light enough to do no damage. Occasionally, crops are severely damaged.

The annual snowfall averages about 17 inches, but in some seasons it has been less than an inch, and in others it has been more than 40 inches. The snow tends to blow into drifts and soon melts when the temperature rises. It is seldom on the ground for more than a few days.

Winds are strong because there are no sheltering mountain ranges or timbered areas. March and April are the windiest months. The average wind velocity is about 13.4 miles per hour in March, and 14.1 miles per hour in April. The prevailing winds come from the south. The strongest winds are from the north, and they normally come in winter. Winds of more than 65 miles per hour have been recorded.

Low precipitation in winter, combined with strong winds, causes duststorms when the soils dry in spring. Improved methods of tillage, mentioned in the section, Use and Management of Soils, have been helpful in controlling dust storms.

The average humidity is low. On the average, there are only 6 foggy days; they occur in winter and spring. Crops may be damaged when winds are strong and the humidity is low. The plants lose moisture to the air too rapidly. Humidity is highest in the morning and lowest in the afternoon. The average rate of evaporation from a free water surface is about 53 inches a year.

The average growing season at Spearman is about 184 days. The average date of the last frost in spring is April 20, and the average first in fall, October 22. The latest killing frost recorded was on May 14, and the earliest recorded, on October 5.

Water Supply

Most of the county has good water at depths of 200 to 350 feet. Wells have provided sufficient water for livestock and domestic use. In the last few years, the number of irrigation wells has greatly increased.

Settlement and Population

The first settlers in the area now covered by Hansford County were two buffalo hunters, Bob and Jim Cator, who came from Dodge City, Kans., in 1873. They settled on Palo Duro Creek, just north of the present townsite of Morse. Other hunters followed, and by 1876, the buffalo were becoming scarce. In June 1878, the Cators brought the first herd of cattle into the area and started ranching.

Indian uprisings and lack of water retarded settlement, but after the 1880's, the number of ranchers increased. Most of the settlers were from Kansas, and of English descent. In 1909, settlers of Norwegian descent began to come from Iowa, Wisconsin, Minnesota, and the Dakotas. They settled in the northwestern part of the county.

The county was organized in 1889. The site of the county seat was old Hansford, which was about 10 miles downstream from the old Cator headquarters on Palo Duro Creek. The county seat was moved to Spearman in 1928, and most of the residents of Hansford moved to Spearman.

In 1950, the population of the county was 4,202. Spearman had a population of 1,852; Gruver, 813; Morse, 103; and Hitchland, 70. The population of the county dropped during the severe drought of the 1930's, but this has been more than offset by gains in population between 1940 and 1950.

Community Facilities

The towns of Spearman, Gruver, and Morse each have an elementary school and a high school. The community of Olso has an elementary school, as does the community at Phillips Camp. Spearman has a city library, county hospital, swimming pool, and golf course. Churches of many faiths are located in the county.

The treeless plains of the county provide little hunting and fishing. Scattered groves of trees along many of the streams are good spots for picnics.

Transportation

The county has two rail lines. A line of the Chicago, Rock Island and Pacific runs north through Morse, Gruver, Bernstein, and Hitchland. A line of the Santa Fe Railway enters on the eastern border, passes through

Spearman, and joins the Chicago, Rock Island and Pacific line at Morse.

Hard-surfaced highways connect the towns and more populated parts of the county.

Industry

Agriculture is the main enterprise in the county. Secondary in importance is production and processing of oil and gas. The first producing well was drilled in 1928. At present there are 315 producing oil and gas wells, one gas stripping plant, and one gas booster station in the county.

Agriculture

The agriculture of Hansford County began in 1878, when the Cator brothers brought in a herd of cattle—11 cows, 10 heifers, and 42 yearlings. Other ranchers followed. The early ranchers grew a few plots of grain sorghum to feed saddle horses, and they planted small acreages of alfalfa along the valley bottoms.

Wheat probably was first grown in 1904 or 1905, but the increase in acreage was slow. In 1914, the fields of wheat were still scattered. Oldtime threshers state that they had to pull their machines 4 or 5 miles between fields.

The first World War increased demand for wheat, and many acres of prairie were plowed and planted. Improvement in farm machinery made it practical to farm larger acreages than in the past. The first gasoline tractors came to the county about 1915.

In 1926, the wheat crop yielded 30 to 40 bushels an acre and, as a result, there was great expansion in wheat acreage. Since that time, there has been much fluctuation in acreage. The harvested acreage drops in dry years and increases in years when moisture supplies are favorable.

Wheat has always been the main cultivated crop. It is a cash crop and also provides winter grazing. Recently, more acreage has been planted to grain sorghum. Many farmers now plant wheat and sorghum in rotation. If the winter and spring moisture supply is so unfavorable that failure of the wheat crop can be expected, the wheat may be plowed under and sorghum planted as a catch crop. Oats and barley are also used in this way. Recently, a few farmers have been growing cotton on irrigated land. The acreages of principal crops are listed in table 9 for stated census years.

TABLE 9.—*Acreage of principal crops in stated years*

Crops	1939	1949	1954
Small grains threshed or combined:	*Acres*	*Acres*	*Acres*
Wheat	155, 528	276, 785	112, 843
Oats	1, 425	447	340
Barley	5, 906	369	1, 742
Sorghum for all purposes except for sirup	5, 773	10, 281	89, 989
Alfalfa	(1)	344	551
Cotton	(2)	(2)	105

[1] Less than 3 farms reporting. Data included only in State totals.
[2] Not reported.

The number of livestock in the county is listed in table 10 for stated years. These figures are not particularly significant, as the livestock population varies according to the amount of rainfall. In dry years, there is not enough grass on the range, so the number of cattle decreases. Beef cattle, mainly Hereford, far outnumber all other kinds of livestock. There are a few herds of Aberdeen Angus. Farmers keep a few milk cows for domestic use.

TABLE 10.—*Number of livestock on farms in stated years*

Livestock	1940	1950	1954
	Number	*Number*	*Number*
Horses and mules	[1] 495	685	543
Cattle and calves	[1] 17, 906	21, 694	41, 474
Hogs and pigs	[2] 1, 066	799	718
Sheep and lambs	[3] 3, 971	1, 998	1, 816
Chickens	[2] 17, 721	[2] 13, 506	[2] 12, 346

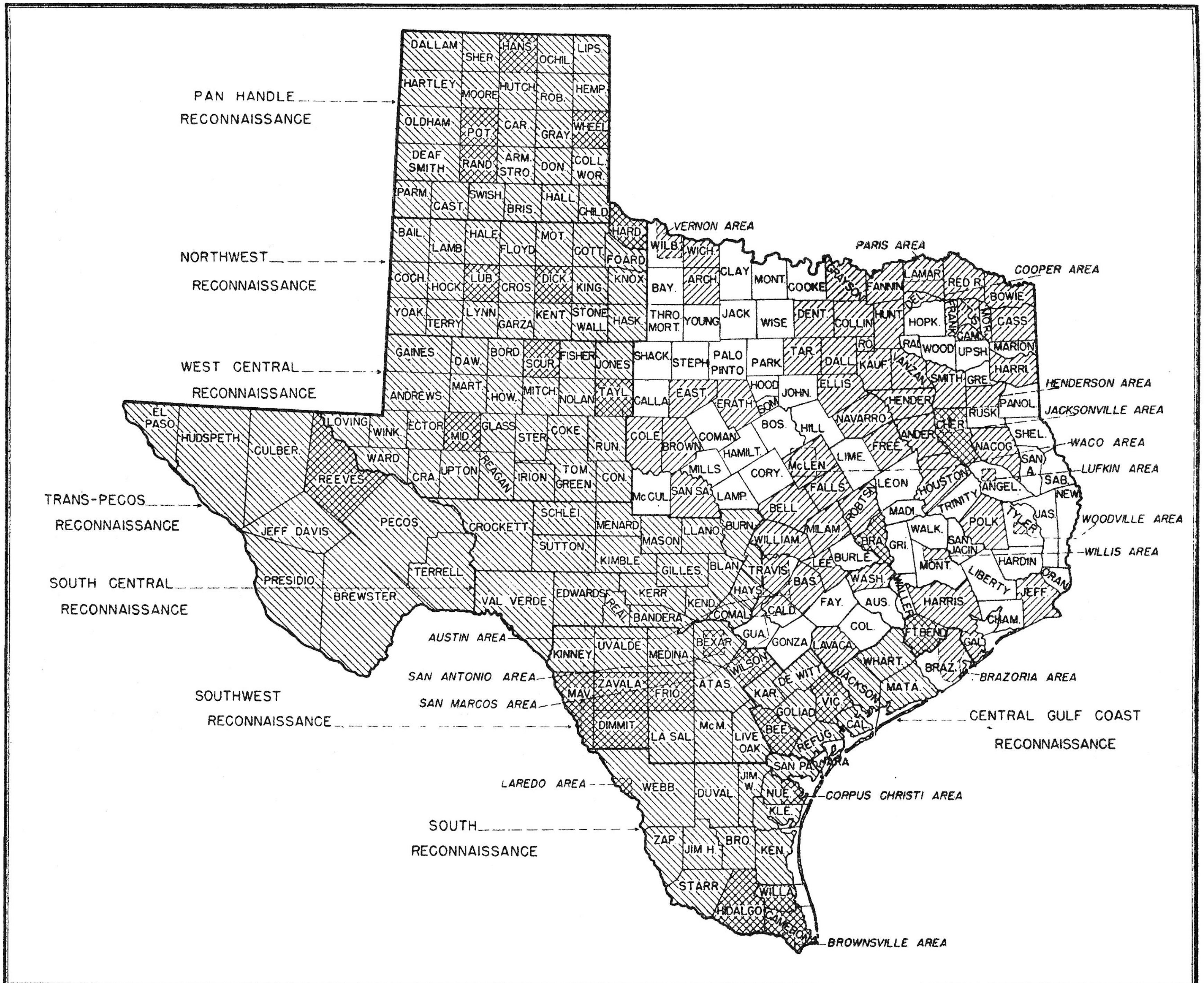
[1] Over 3 months old.
[2] Over 4 months old.
[3] Over 6 months old.

GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND RANGE SITES

[See table 1, p. 12, for estimated average acre yields for cultivated soils, and table 5, p. 23, for approximate acreage and proportionate extent of the soils. See pp. 15 to 16 for information on engineering properties of the soils]

Map symbol	Mapping unit	Page	Capability unit				Range site	Page
			Dryland	Page	Irrigated	Page		
BbD	Bippus fine sandy loam, 5 to 8 percent slopes.	23	VIe-2 (D)	7	(1)		Mixed land slopes	14
BbC	Bippus fine sandy loam, 3 to 5 percent slopes.	24	IVe-1 (D)	7	IVe-1 (Ir)	11	Mixed land slopes	14
BbB	Bippus fine sandy loam, 1 to 3 percent slopes.	24	IIIe-3 (D)	6	IIIe-4 (Ir)	11	Mixed land slopes	14
BaB	Bippus clay loam, 1 to 3 percent slopes	24	IIIe-2 (D)	6	IIIe-3 (Ir)	10	Hardland slopes	14
BaC	Bippus clay loam, 3 to 8 percent slopes	24	VIe-1 (D)	7	(1)		Hardland slopes	14
DbA	Dalhart sandy clay loam, 0 to 1 percent slopes.	25	IIIec-2 (D)	6	IIe-1 (Ir)	9	Hardland	14
DbB	Dalhart sandy clay loam, 1 to 3 percent slopes.	25	IIIe-2 (D)	6	IIIe-2 (Ir)	10	Hardland	14
DaA	Dalhart fine sandy loam, 0 to 1 percent slopes.	25	IIIe-3 (D)	6	IIe-2 (Ir)	9	Mixed land	14
DaB	Dalhart fine sandy loam, 1 to 3 percent slopes.	25	IIIe-3 (D)	6	IIIe-4 (Ir)	11	Mixed land	14
LaC	Likes loamy fine sand, 1 to 8 percent slopes.	26	VIe-3 (D)	7	(1)		Sandhills	14
MaB	Mansker clay loam, 1 to 3 percent slopes	26	IVe-1 (D)	7	IIIe-5 (Ir)	11	Hardland slopes	14
MaA	Mansker clay loam, 0 to 1 percent slopes	26	IVe-1 (D)	7	IIIe-5 (Ir)	11	Hardland slopes	14
MaC	Mansker clay loam, 3 to 6 percent slopes	27	VIe-4 (D)	7	(1)		Caliche shallow land	15
PaA	Portales silty clay loam, 0 to 1 percent slopes.	27	IIIec-2 (D)	6	IIe-2 (Ir)	9	Hardland	14
PaB	Portales silty clay loam, 1 to 3 percent slopes.	28	IIIe-2 (D)	6	IIIe-3 (Ir)	10	Hardland	14
PbC	Potter soils, 0 to 8 percent slopes	28	VIe-4 (D)	7	(1)		Caliche shallow land	15
PbF	Potter soils, 8 to 30 percent slopes	28	VIIs-1 (D)	8	(1)		Caliche breaks	15
PcC	Potter-Mansker soils, 0 to 8 percent slopes.	28	VIe-4 (D)	7	(1)		Caliche shallow land	15
PdA	Pullman silty clay loam, 0 to 1 percent slopes.	29	IIIec-1 (D)	6	IIs-1 (Ir)	9	Hardland	14
PdB	Pullman silty clay loam, 1 to 3 percent slopes.	29	IIIe-1 (D)	5	IIIe-1 (Ir)	10	Hardland	14
PdB2	Pullman silty clay loam, 1 to 3 percent slopes, eroded.	30	IIIe-1 (D)	5	(1)		Hardland	14
Ra	Randall clay	30	VIw-1 (D)	8	(1)		Hardland	14
Sa	Sandy alluvial land	30	VIe-3 (D)	7	(1)		Sandhills	14
Sb	Spur clay loam, high	31	IIIec-1 (D)	6	IIe-1 (Ir)	9	Dry bottom-land	14
Sc	Spur clay loam, low	31	Vw-1 (D)	7	(1)		Dry bottom-land	14
Sd	Spur fine sandy loam, high	31	IIIe-3 (D)	6	IIe-2 (Ir)	9	Dry bottom-land	14
Se	Spur fine sandy loam, low	32	Vw-1 (D)	7	(1)		Dry bottom-land	14
Sf	Spur soils	32	Vw-1 (D)	7	(1)		Dry bottom-land	14
Sg	Stony rough land, Potter material	32	VIIs-1 (D)	8	(1)		Caliche breaks	15
VaB	Vona loamy fine sand, 1 to 5 percent slopes.	33	VIe-3 (D)	7	(1)		Sandhills	14
ZaA	Zita silty clay loam, 0 to 1 percent slopes.	33	IIIec-1 (D)	6	IIe-1 (Ir)	9	Hardland	14
ZaB	Zita silty clay loam, 1 to 3 percent slopes.	34	IIIe-1 (D)	5	IIIe-2 (Ir)	10	Hardland	14

[1] Considered unsuitable for irrigation.



Areas surveyed shown by shading. Northwest-southeast hatching denotes reconnaissance surveys, and northeast-southwest hatching shows detailed surveys. Cross-hatching indicates areas surveyed both ways.

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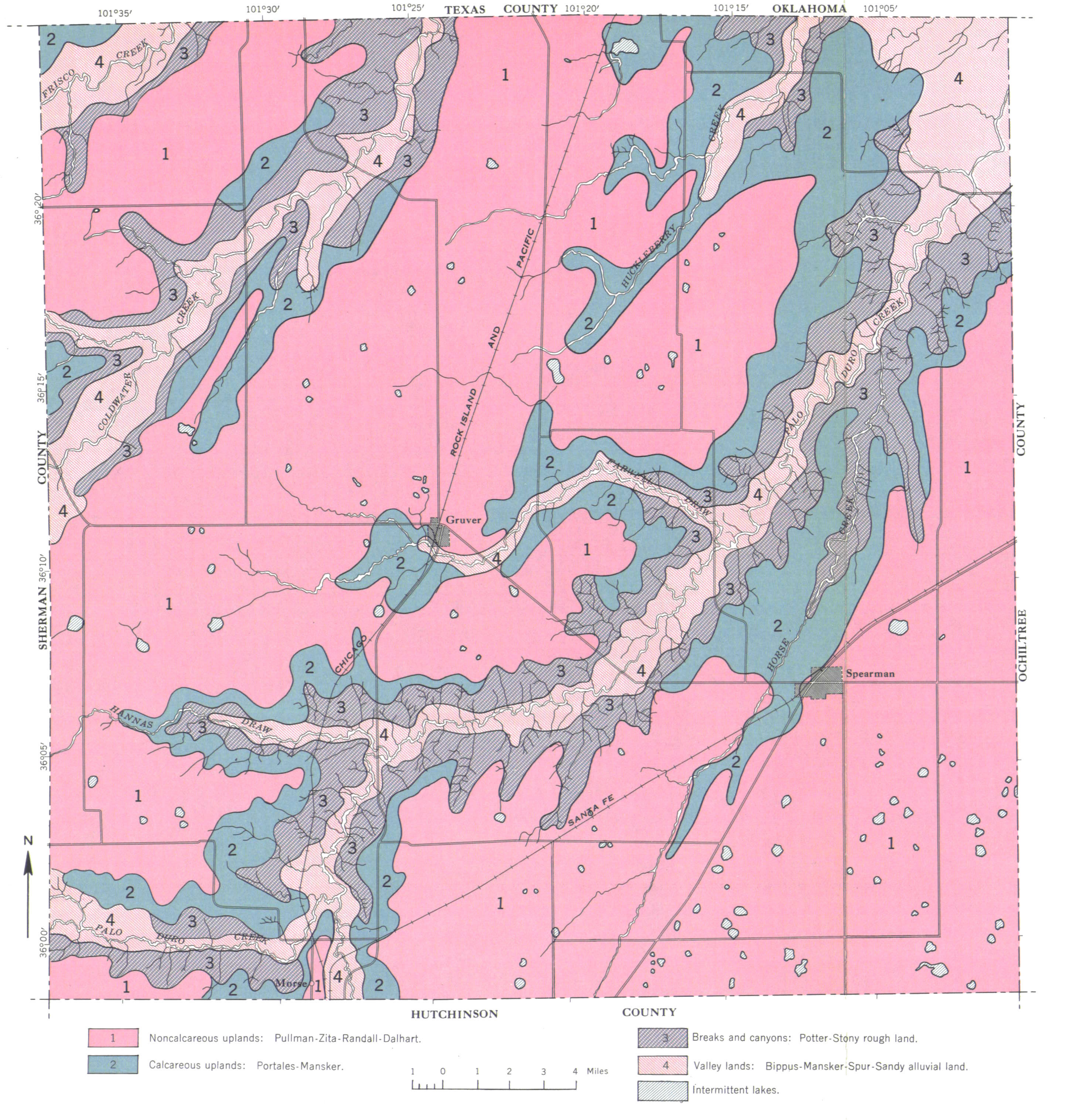
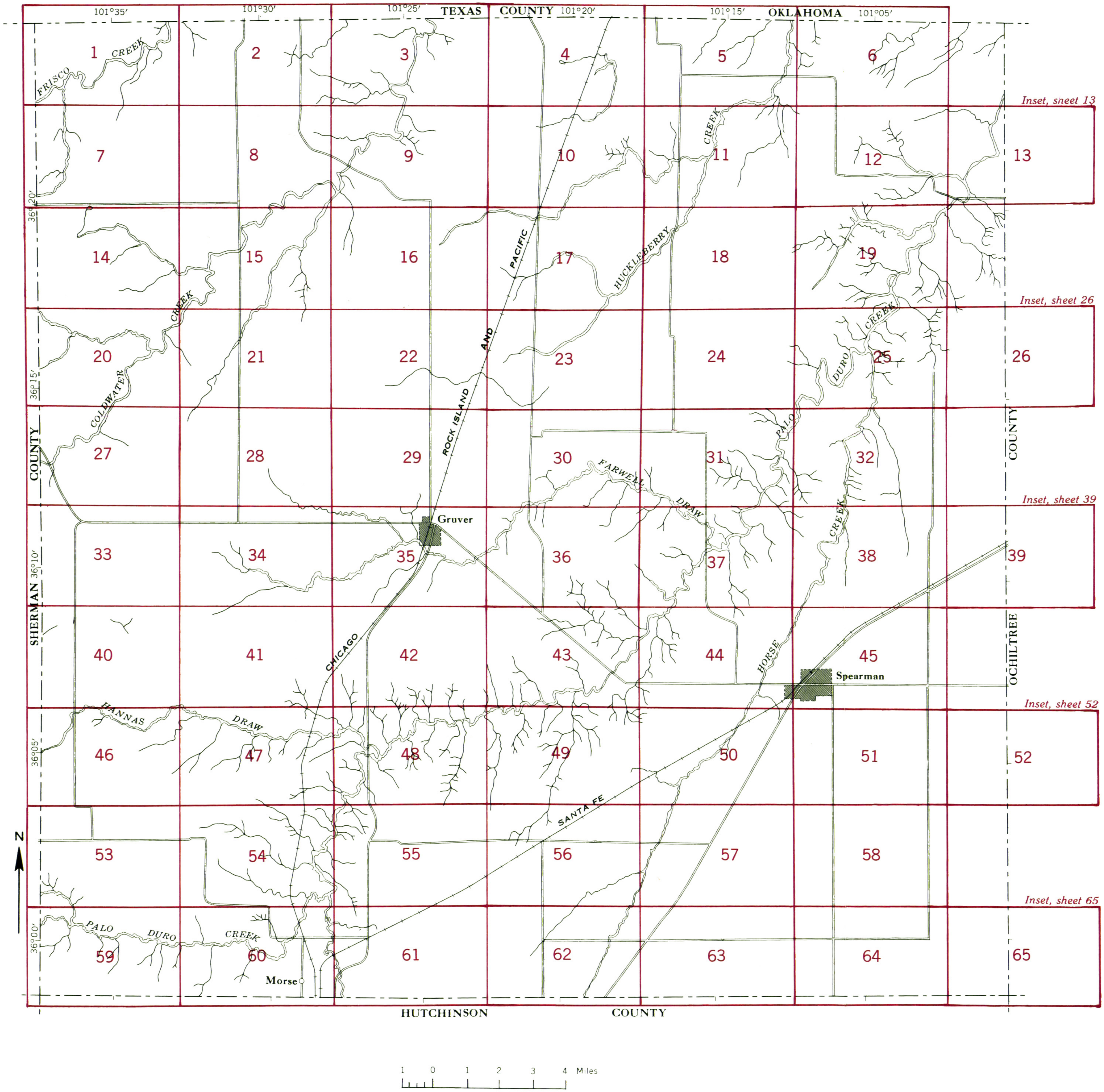
GENERAL SOIL MAP
HANSFORD COUNTY, TEXAS



INDEX TO MAP SHEETS
HANSFORD COUNTY, TEXAS



SOILS LEGEND

SYMBOL	NAME
BaB	Bippus clay loam, 1-3 percent slopes
BaC	Bippus clay loam, 3-8 percent slopes
BbB	Bippus fine sandy loam, 1-3 percent slopes
BbC	Bippus fine sandy loam, 3-5 percent slopes
BbD	Bippus fine sandy loam, 5-8 percent slopes
DaA	Dalhart fine sandy loam, 0-1 percent slopes
DaB	Dalhart fine sandy loam, 1-3 percent slopes
DbA	Dalhart sandy clay loam, 0-1 percent slopes
DbB	Dalhart sandy clay loam, 1-3 percent slopes
LaC	Likes loamy fine sand, 1-8 percent slopes
MaA	Mansker clay loam, 0-1 percent slopes
MaB	Mansker clay loam, 1-3 percent slopes
MaC	Mansker clay loam, 3-6 percent slopes
PaA	Portales silty clay loam, 0-1 percent slopes
PaB	Portales silty clay loam, 1-3 percent slopes
PbC	Potter soils, 0-8 percent slopes
PbF	Potter soils, 8-30 percent slopes
PcC	Potter-Mansker soils, 0-8 percent slopes
PdA	Pullman silty clay loam, 0-1 percent slopes
PdB	Pullman silty clay loam, 1-3 percent slopes
PdB2	Pullman silty clay loam, 1-3 percent slopes, eroded
Ra	Randall clay
Sa	Sandy alluvial land
Sb	Spur clay loam, high
Sc	Spur clay loam, low
Sd	Spur fine sandy loam, high
Se	Spur fine sandy loam, low
Sf	Spur soils
Sg	Stony rough land, Potter material
VaB	Vona loamy fine sand, 1-5 percent slopes
ZaA	Zita silty clay loam, 0-1 percent slopes
ZaB	Zita silty clay loam, 1-3 percent slopes

Soils surveyed 1956-57 by A. J. Welker, L. L. Jacquot, W. B. Brooks, M. T. Turner, A. D. Moss, P. H. Mohle, and H. F. McEwen, Soil Conservation Service.
Correlation by Harvey Oakes, Soil Conservation Service.

Soil map constructed 1959 by Cartographic Division, Soil Conservation Service, USDA, from 1954 aerial photographs. Controlled mosaic based on Texas plane coordinate system, north zone, Lambert conformal conic projection, 1927 North American datum.

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Roads
- Good motor
- Poor motor
- Trail
- Marker, U. S. — 33

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferry
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church
- Station

Mine and Quarry
- Shaft
- Dump
- Prospect

Pits, gravel or other
Power line
Pipeline
Cemetery
Dam
Levee
Tank
Oil well
Windmill
Canal lock (point upstream)

BOUNDARIES

- National or state
- County
- Township, civil
- Township, U. S.
- Section line, corner
- City (corporate)
- Reservation
- Land grant

DRAINAGE

Streams
- Perennial
- Intermittent, unclass.
  - Crossable with tillage implements
  - Not crossable with tillage implements

Canals and ditches — CANAL / DITCH

Lakes and ponds
- Perennial
- Intermittent

Wells — flowing
Springs
Marsh
Wet spot

RELIEF

Escarpments
- Bedrock
- Other

Prominent peaks

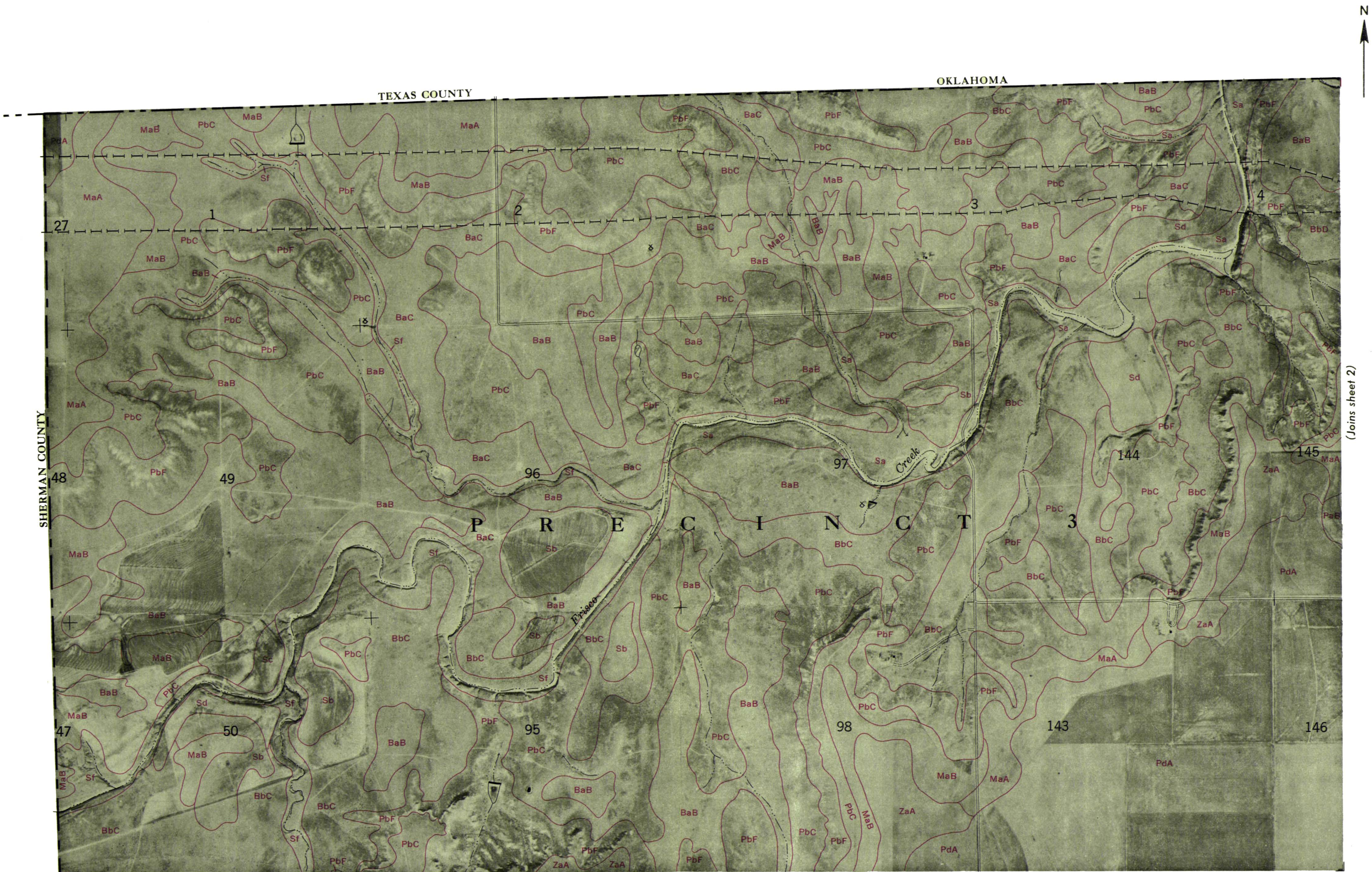
Depressions (Large, Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

Soil type outline and symbol	Dx
Gravel	
Stones	
Rock outcrops	
Chert fragments	
Clay spot	
Sand spot	
Gumbo or scabby spot	
Made land	
Erosion	
Uneroded spot	U
Sheet, moderate	S
Sheet, severe	SS
Gully, moderate	G
Gully, severe	GG
Sheet and gully, moderate	SG
Wind, moderate	
Wind, severe	
Blowout	
Wind hummock	
Overblown soil	
Gullies	
Areas of alkali and salts	
Strong	A
Moderate	M
Slight	S
Free of toxic effect	F
Sample location	26
Saline spot	+

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.



(Joins sheet 2)

(Joins sheet 7)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

2


N
TEXAS COUNTY
OKLAHOMA
Phillips Camp
OIL WASTE PIT
PRECINCT 3
Olso
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 8)
0
1/2
1 Mile
Scale 1:20000
0
5000 Feet

3

N

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

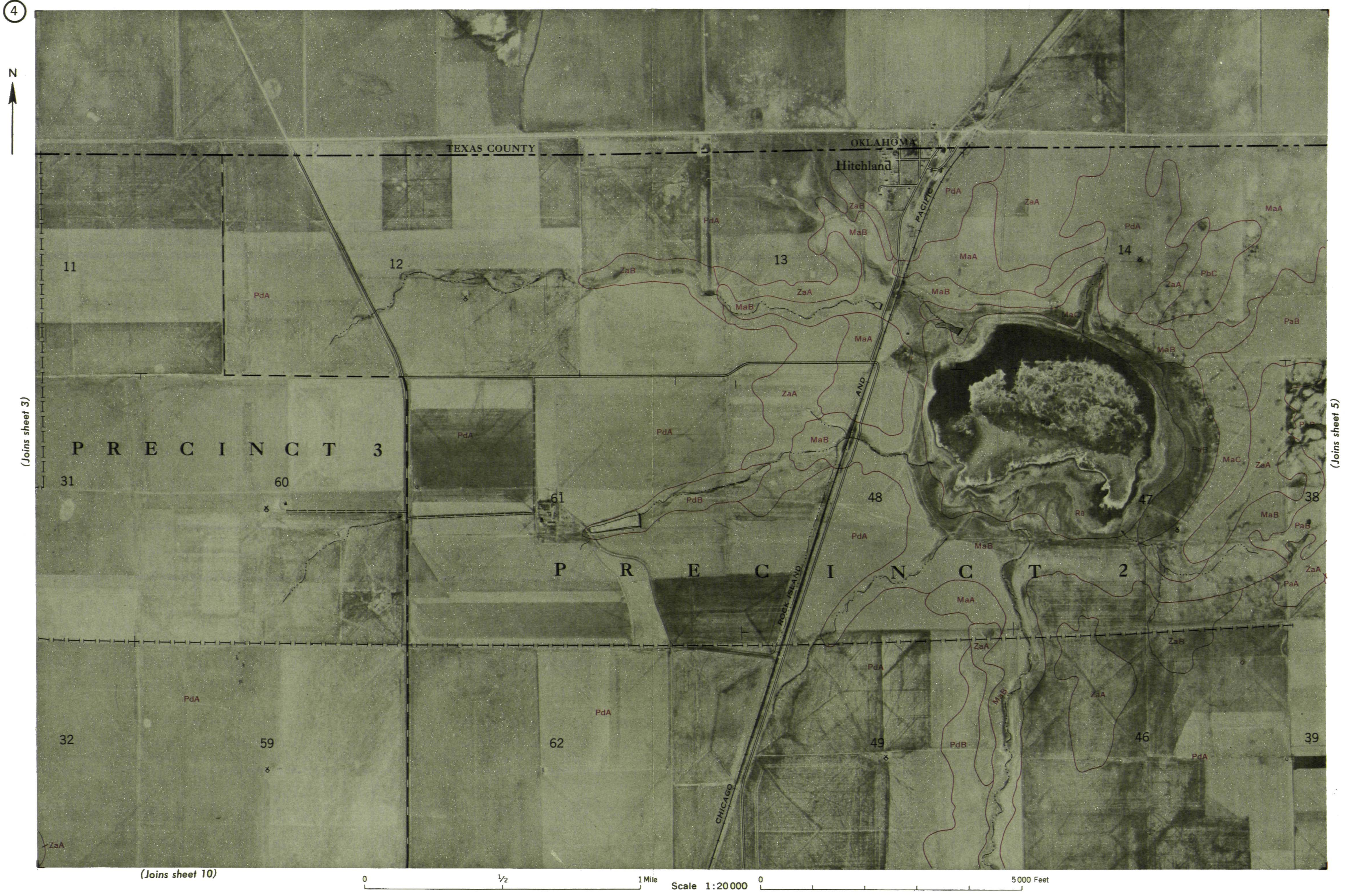
(Joins sheet 2)

(Joins sheet 4)

(Joins sheet 9)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 4



5

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954

Section corners shown on this map are indefinite.

(Joins sheet 4)

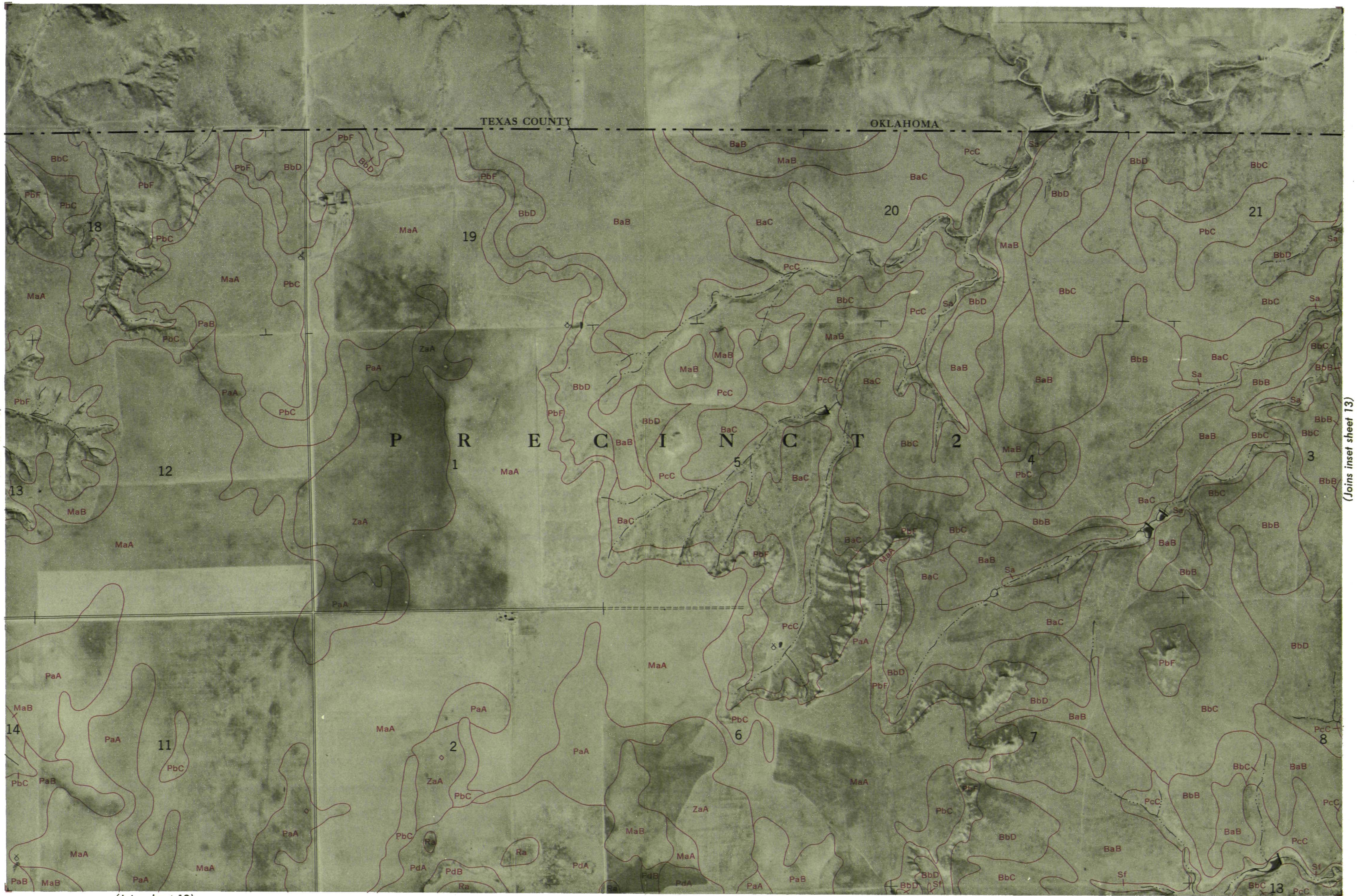
(Joins sheet 6)

(Joins sheet 11)

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

N

(Joins sheet 5)



(Joins inset sheet 13)

(Joins sheet 12)

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 7

(7)

(Joins sheet 1)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

(Joins sheet 8)

0 1/2 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 14)

8

HANSFORD COUNTY, TEXAS - SHEET NUMBER 8

(Joins sheet 2)

N

(Joins sheet 7)

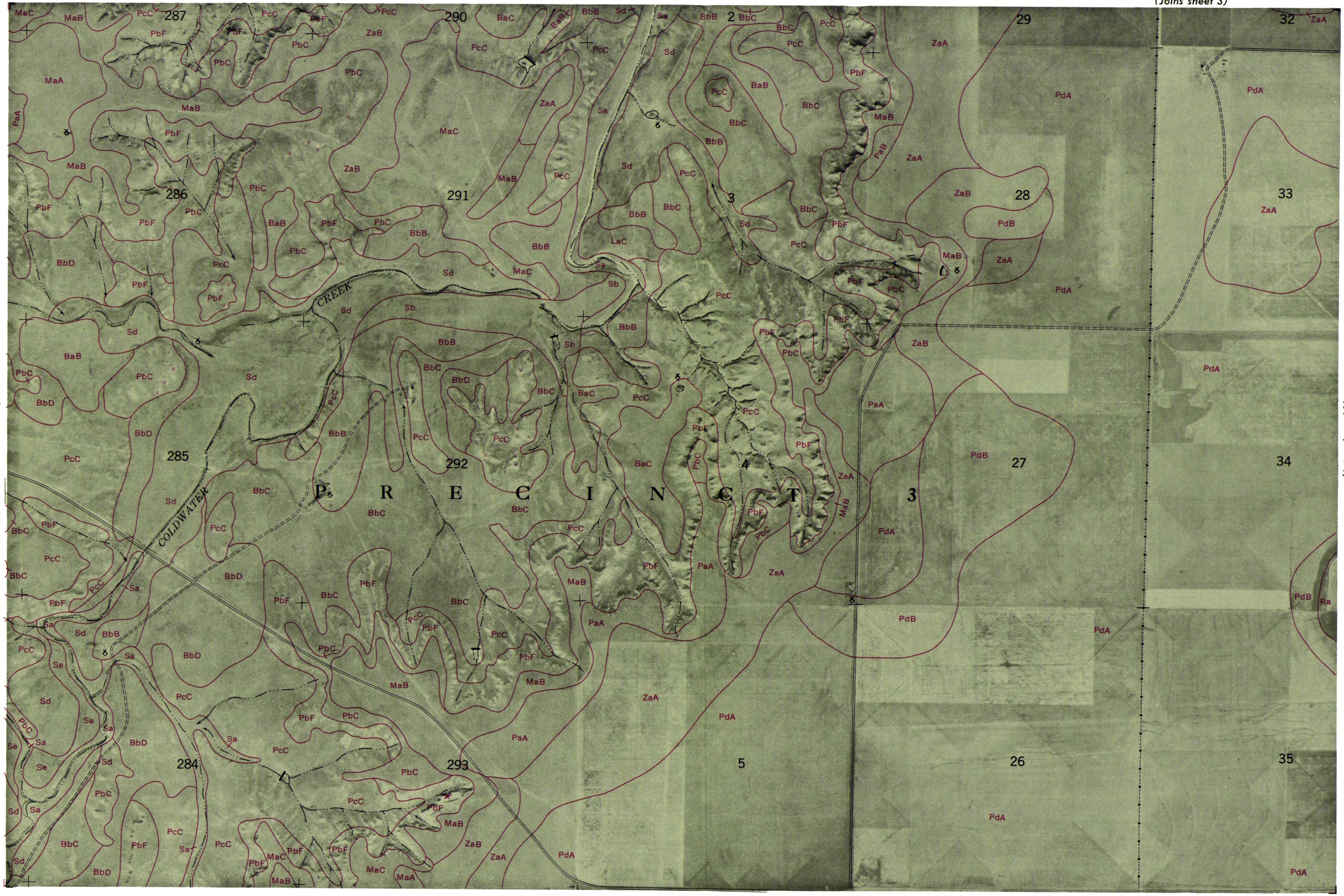
(Joins sheet 9)

(Joins sheet 15)

0 1/2 1 Mile

Scale 1:20000

0 5000 Feet



This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 10

11

(Joins sheet 5)

(Joins sheet 10)

(Joins sheet 12)

(Joins sheet 18)

0 1/2 1 Mile Scale 1:20000 0 5000 Feet

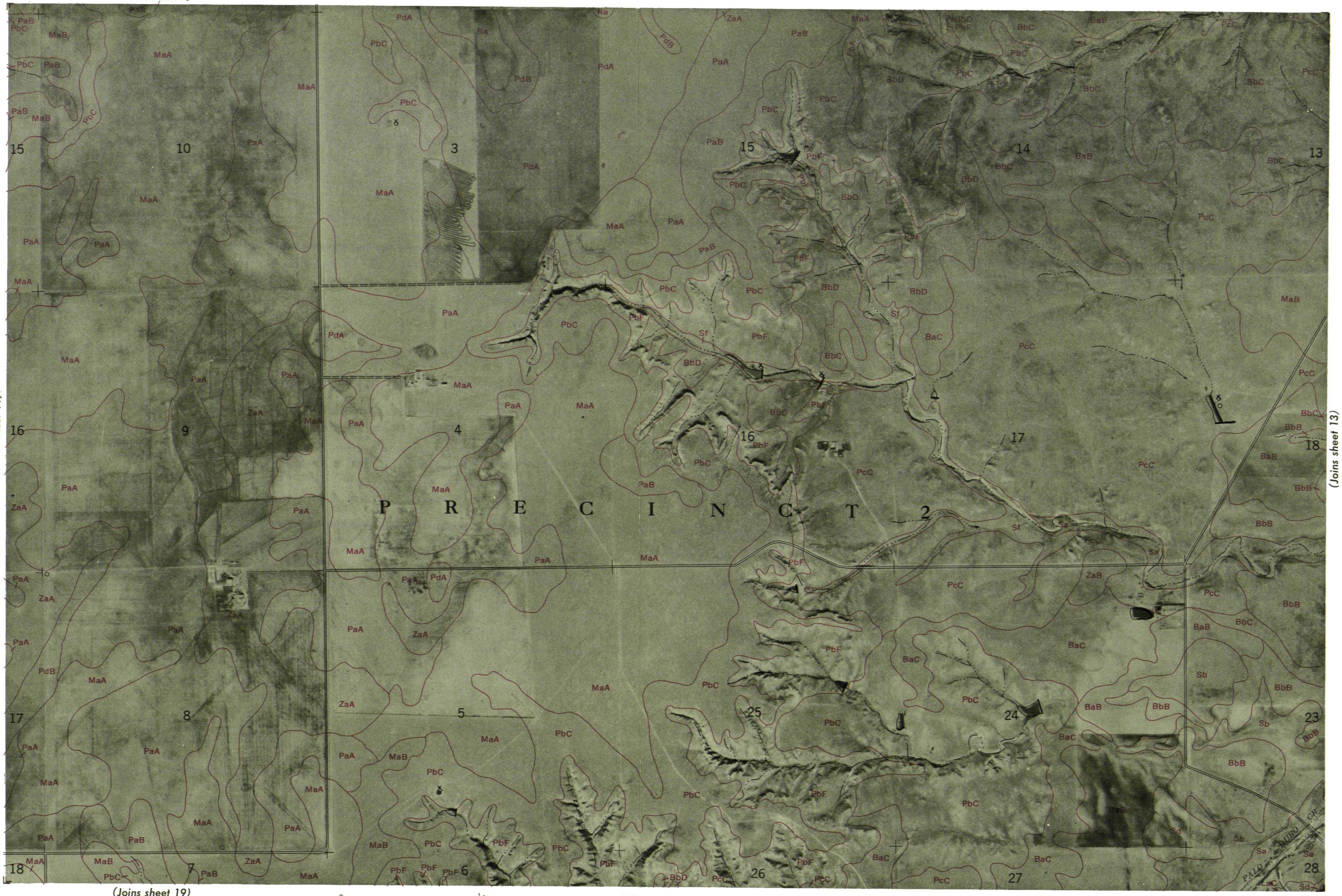
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

HANSFORD COUNTY, TEXAS - SHEET NUMBER 12

(Joins sheet 6)

(Joins sheet 11)



(Joins sheet 13)

(Joins sheet 19)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

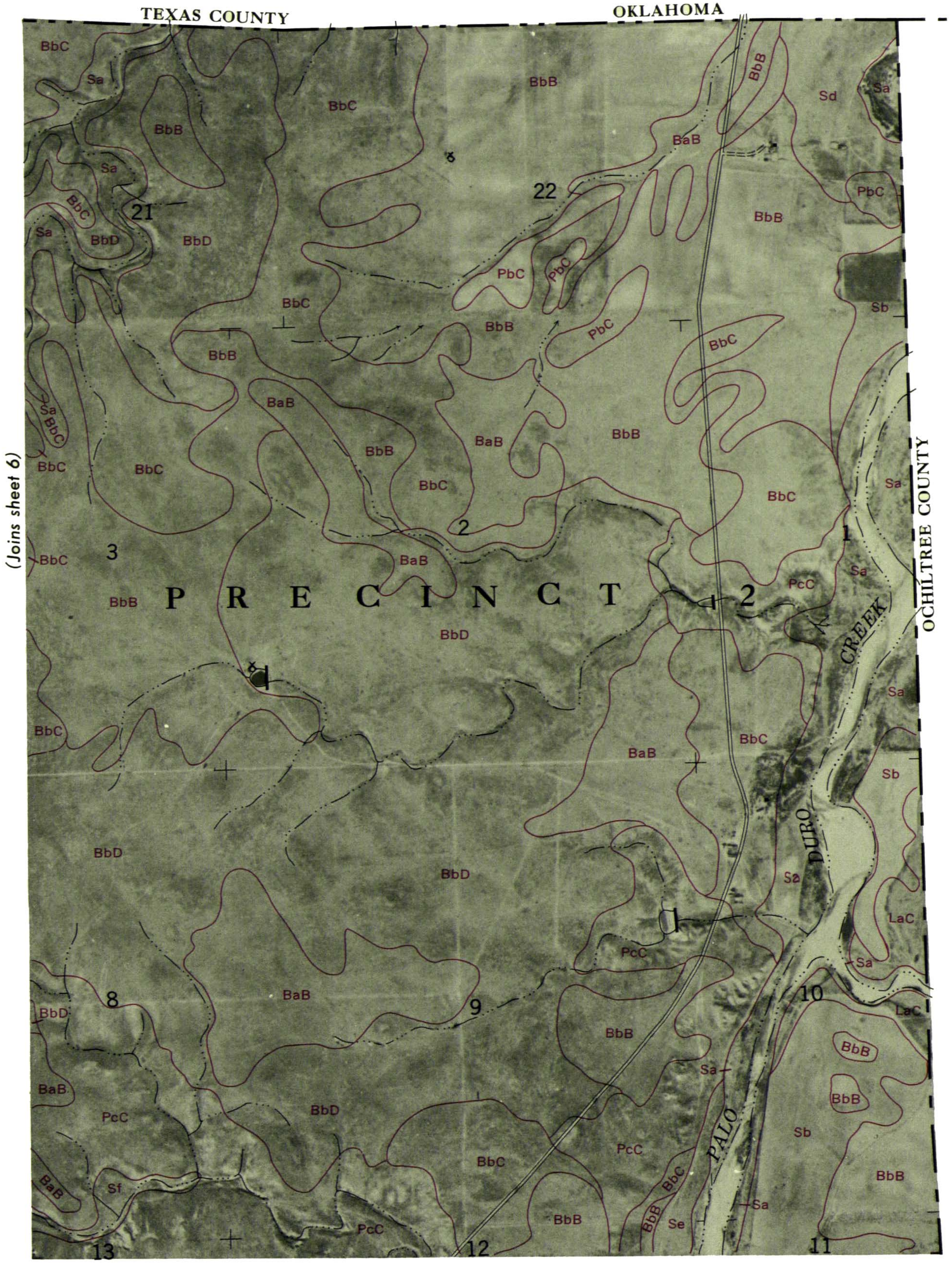
Section corners shown on this map are indefinite.

(Inset right)

(Joins sheet 12)

(Joins inset sheet 26)

N



(Joins sheet 6)

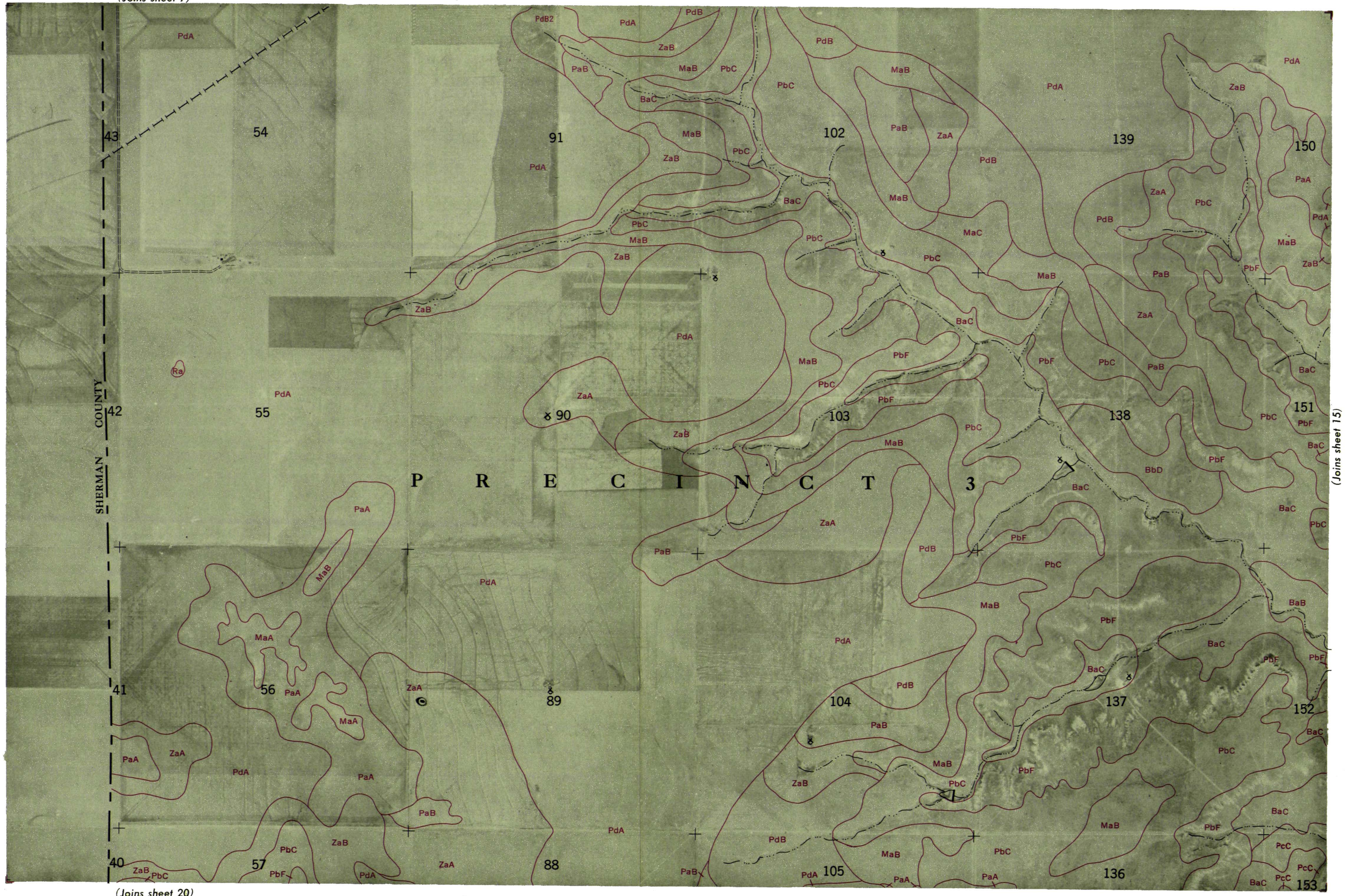
(Joins left above)

0 1/2 1 Mile

Scale 1:20000

0 5000 Feet

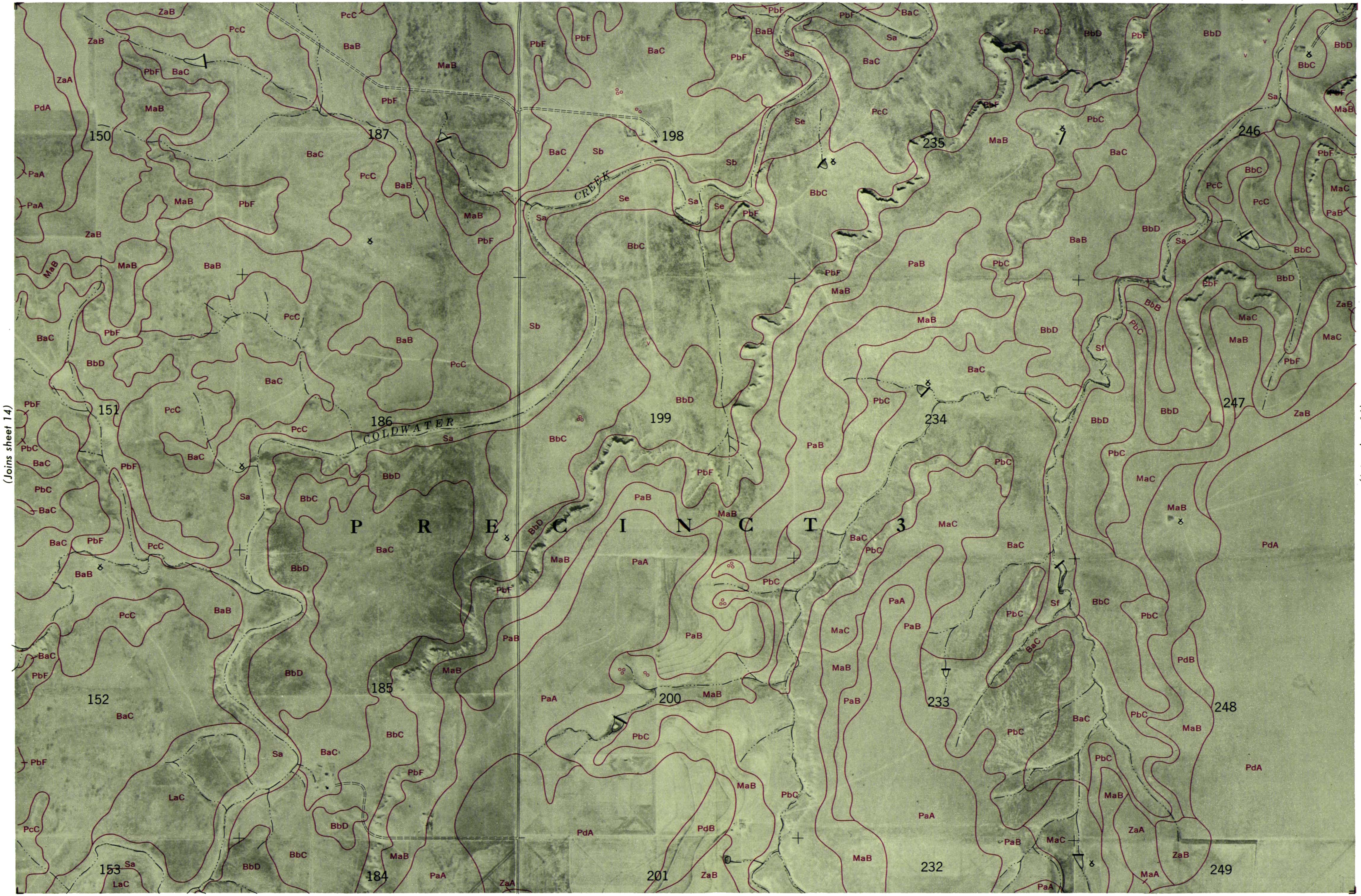
HANSFORD COUNTY, TEXAS - SHEET NUMBER 14



0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

(Joins sheet 8)

15



(Joins sheet 14)

(Joins sheet 16)

(Joins sheet 21)

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

HANSFORD COUNTY, TEXAS - SHEET NUMBER 16

(Joins sheet 9)

(Joins sheet 15)

(Joins sheet 17)

(Joins sheet 22)

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

(Joins sheet 10)

17

N

(Joins sheet 16)

(Joins sheet 18)

(Joins sheet 23)

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

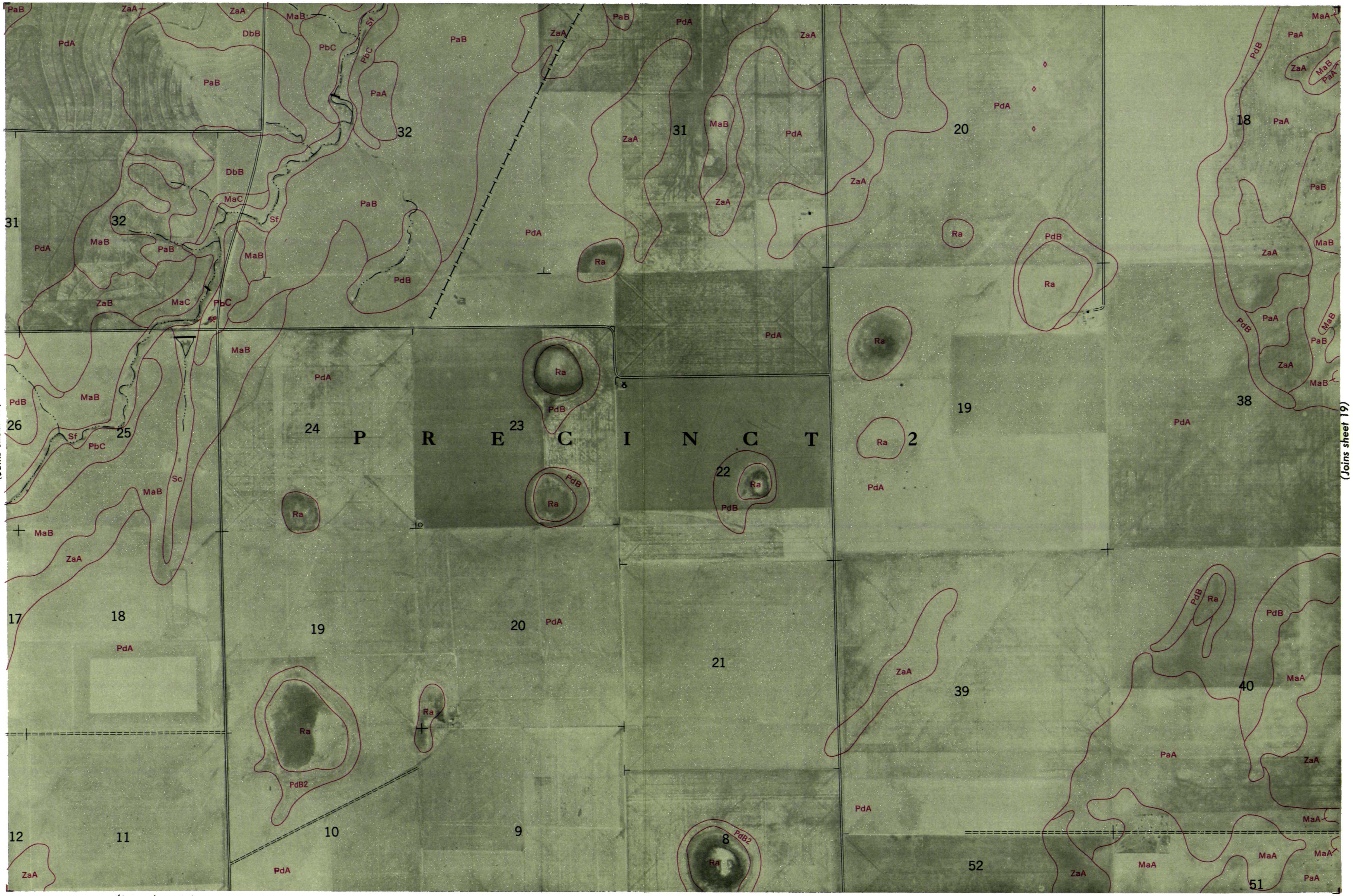
Section corners shown on this map are indefinite.

(18)

HANSFORD COUNTY, TEXAS - SHEET NUMBER 18

(Joins sheet 11)

(Joins sheet 17)



(Joins sheet 19)

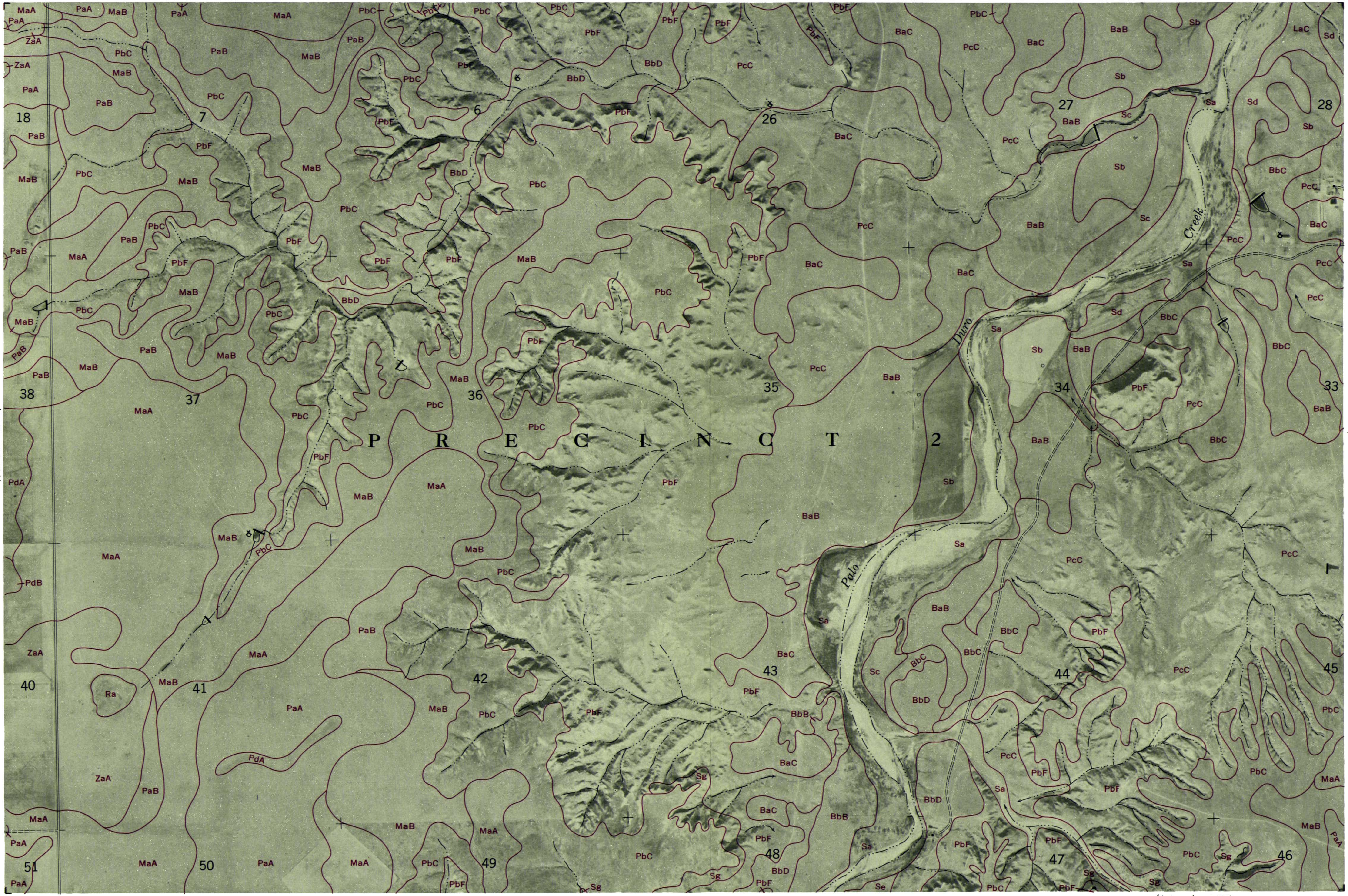
(Joins sheet 24)

0 ½ 1 Mile

Scale 1:20 000

0 5000 Feet

(Joins sheet 12)



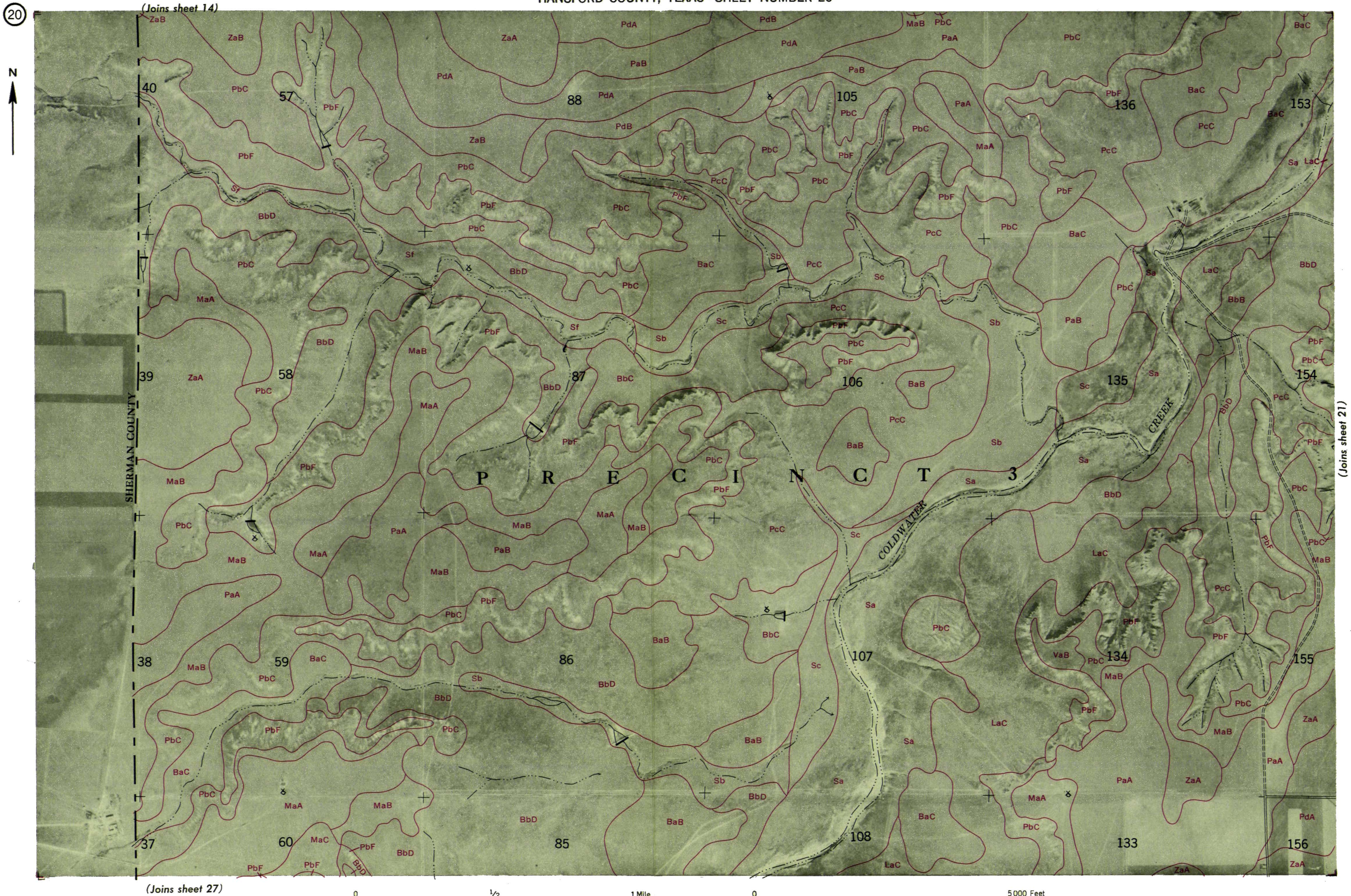
(Joins sheet 25)

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954

Section corners shown on this map are indefinite.

HANSFORD COUNTY, TEXAS - SHEET NUMBER 20



0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

(Joins sheet 15)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

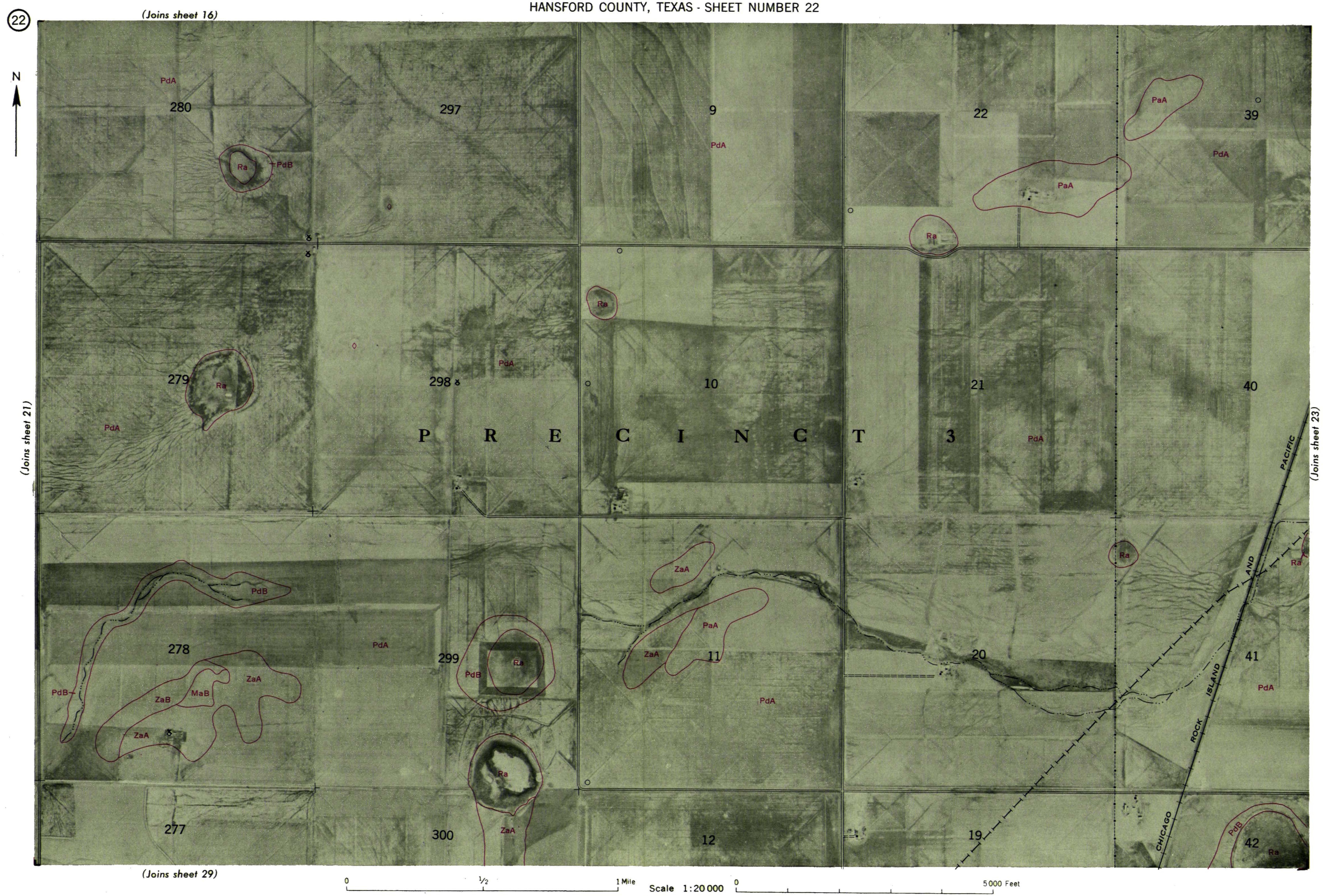
(Joins sheet 20)

(Joins sheet 22)

(Joins sheet 28)

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 22



(Joins sheet 17)

(Joins sheet 22)

(Joins sheet 24)

(Joins sheet 30)

Scale 1:20 000

0 1/2 1 Mile

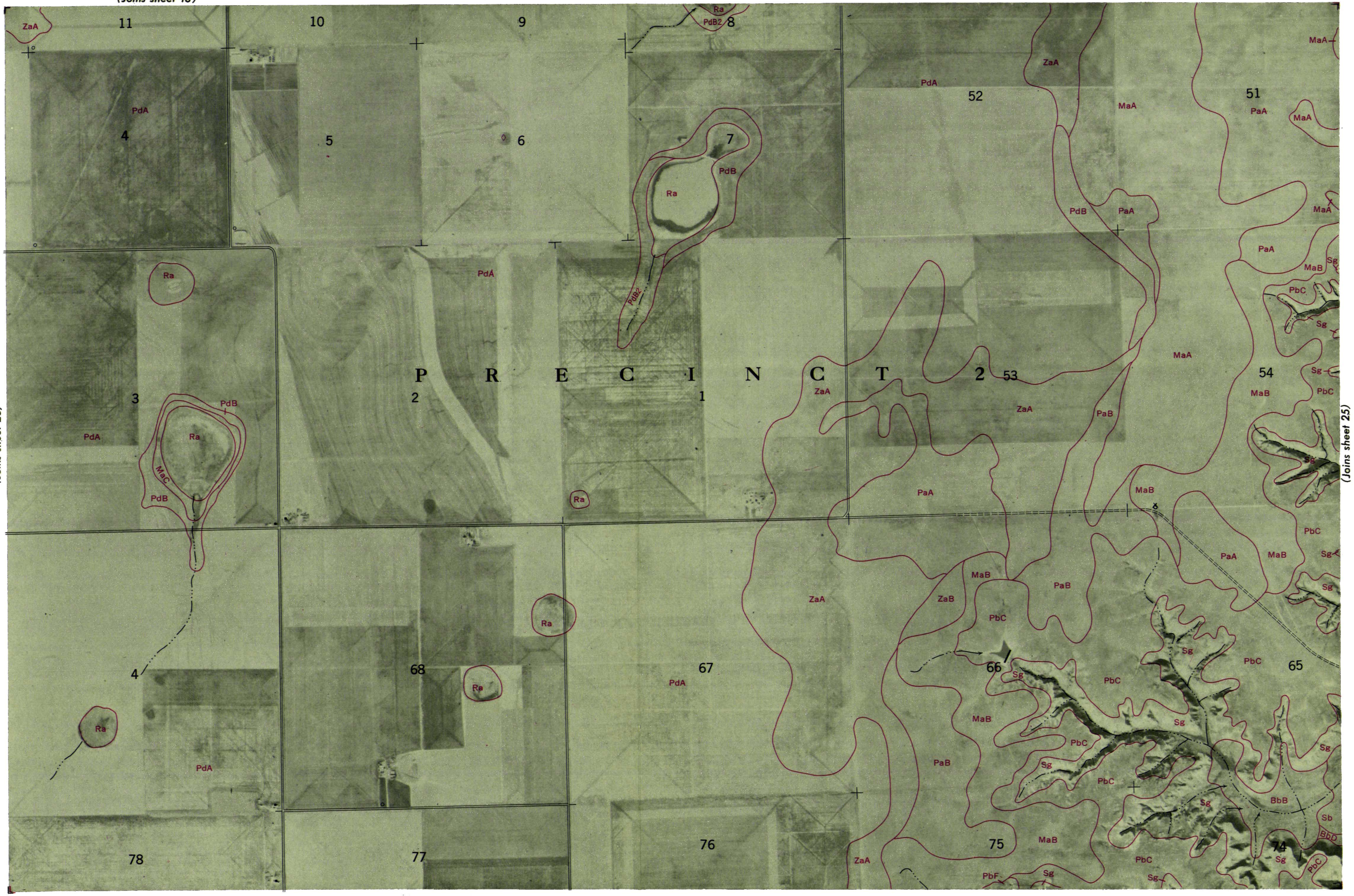
0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954

Section corners shown on this map are indefinite.

24

(Joins sheet 18)



(Joins sheet 23)

(Joins sheet 25)

(Joins sheet 31)

0 1/2 1 Mile

Scale 1:20 000

0 5000 Feet

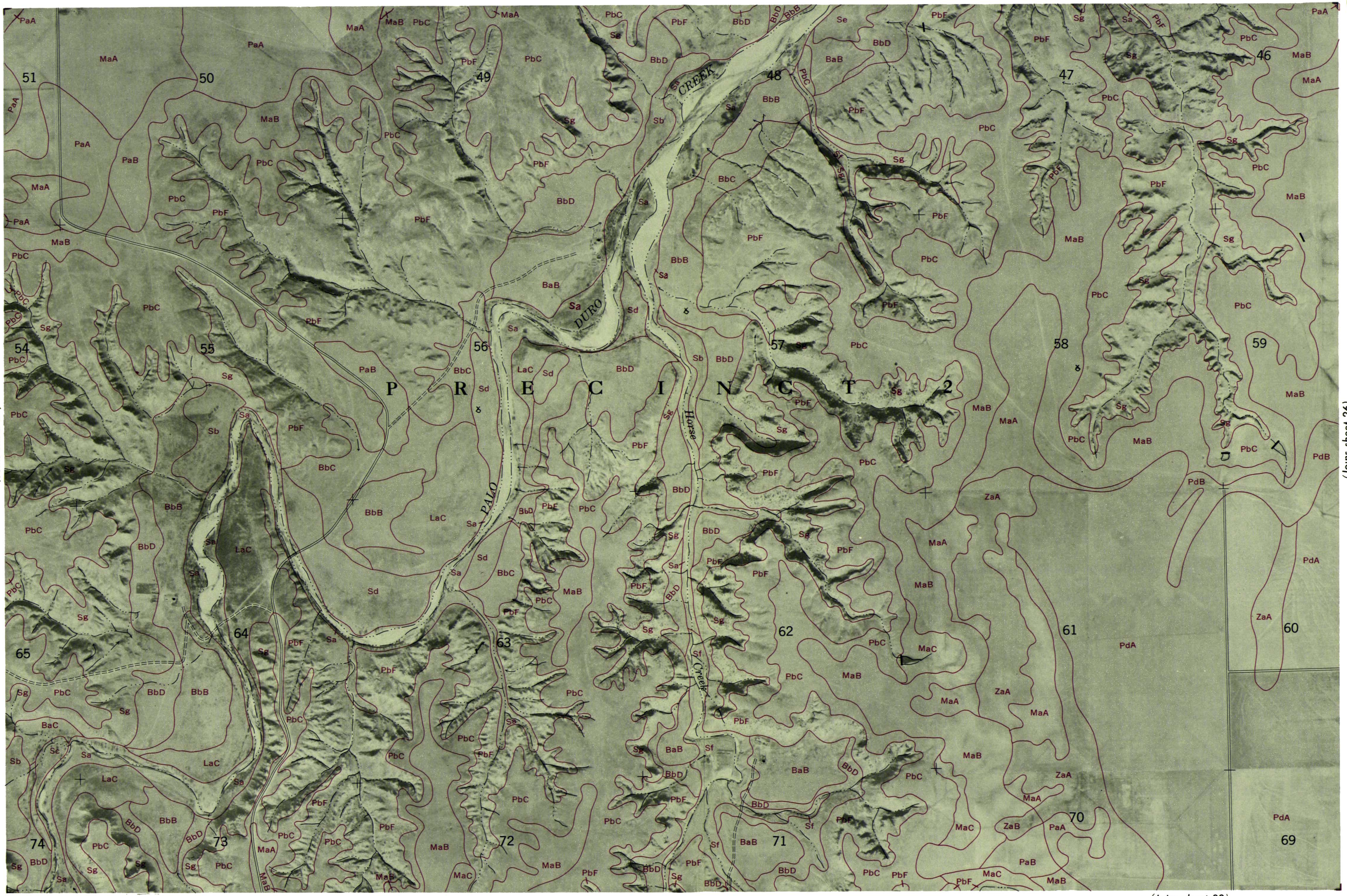
(Joins sheet 19)

(Joins sheet 24)

(Joins sheet 26)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1964

Section corners shown on this map are indefinite.



0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

(Joins sheet 32)

(Inset right)

(Joins inset, sheet 39)

(Joins sheet 13)

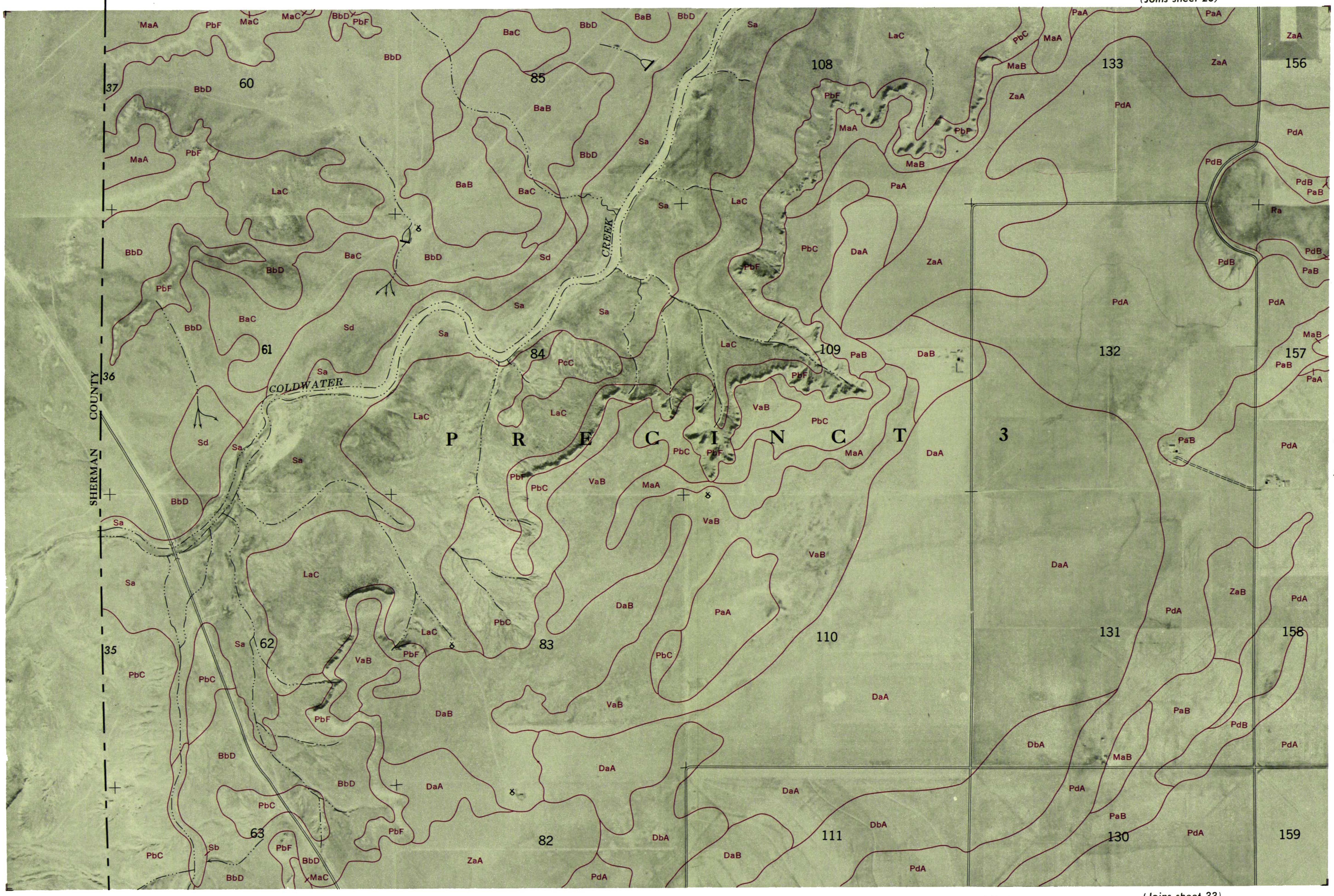
(Joins left above)

Scale 1:20 000

0 ½ 1 Mile

0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 27

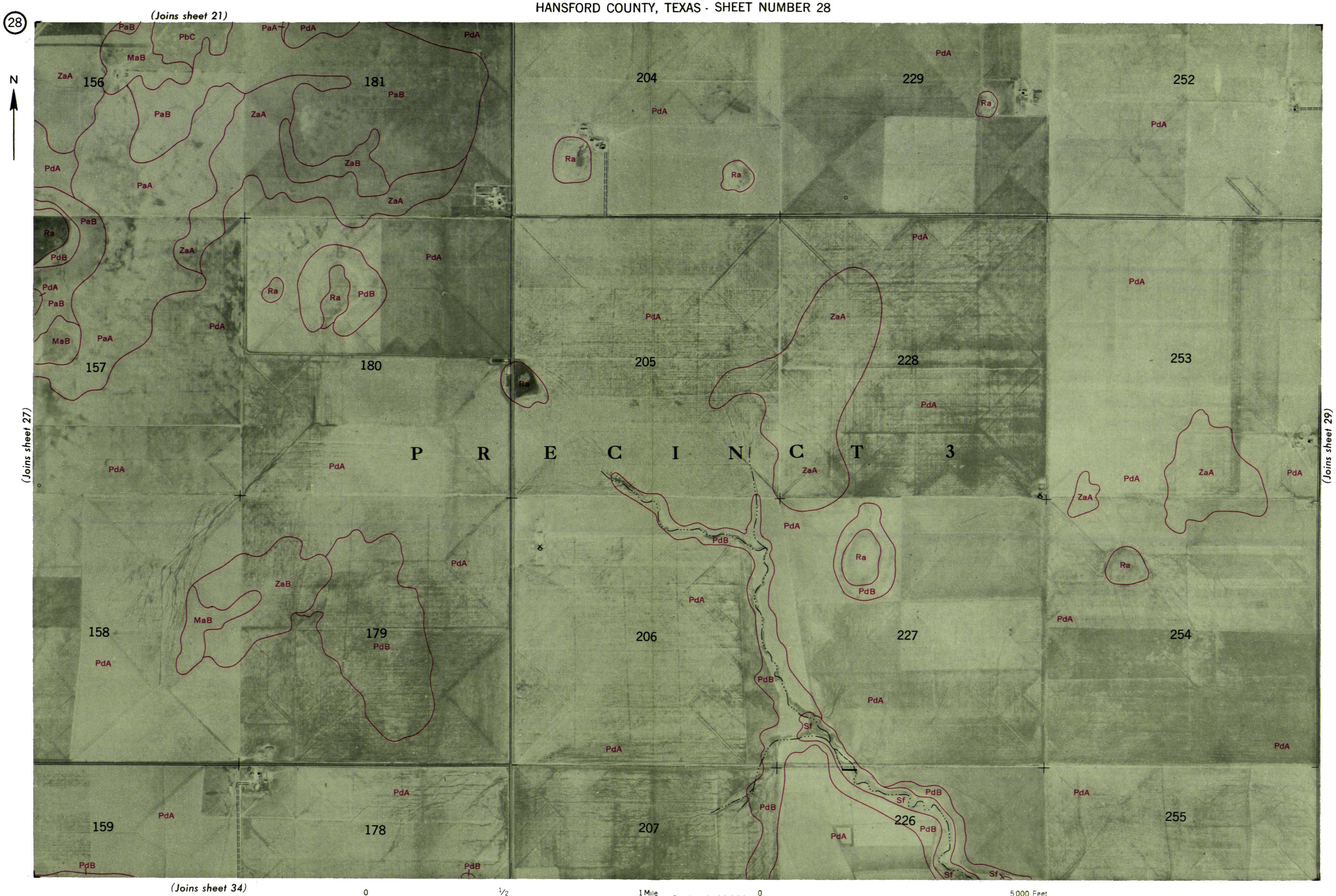


This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

0 1/2 1 Mile Scale 1:20000 0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 28



Scale 1:20 000

0 ½ 1 Mile

0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 29

29

(Joins sheet 22)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954

Section corners shown on this map are indefinite.

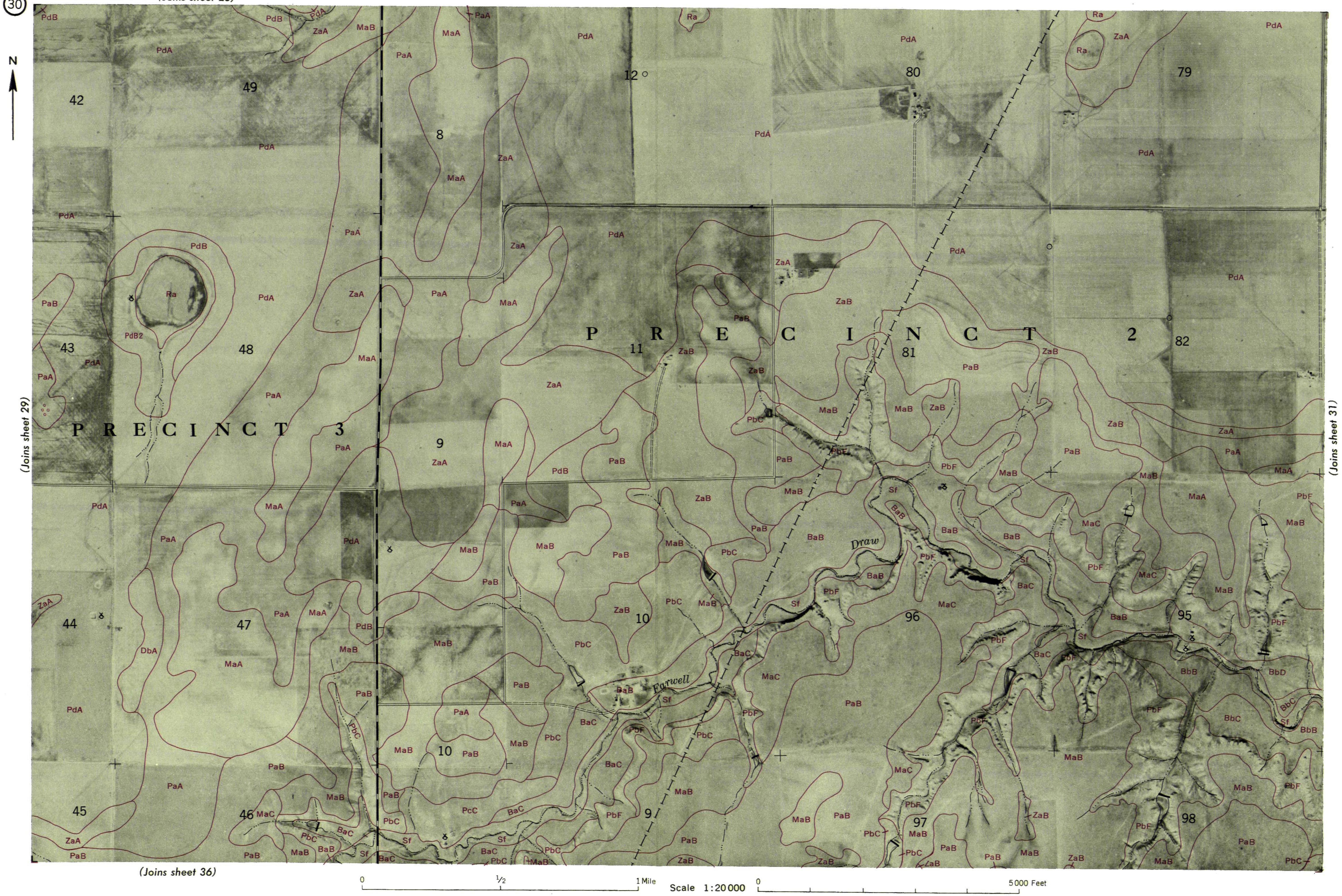
(Joins sheet 28)

(Joins sheet 30)

(Joins sheet 35)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 30



(Joins sheet 24)

31

N

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

(Joins sheet 30)

(Joins sheet 32)

(Joins sheet 37)

0 1/2 1 Mile

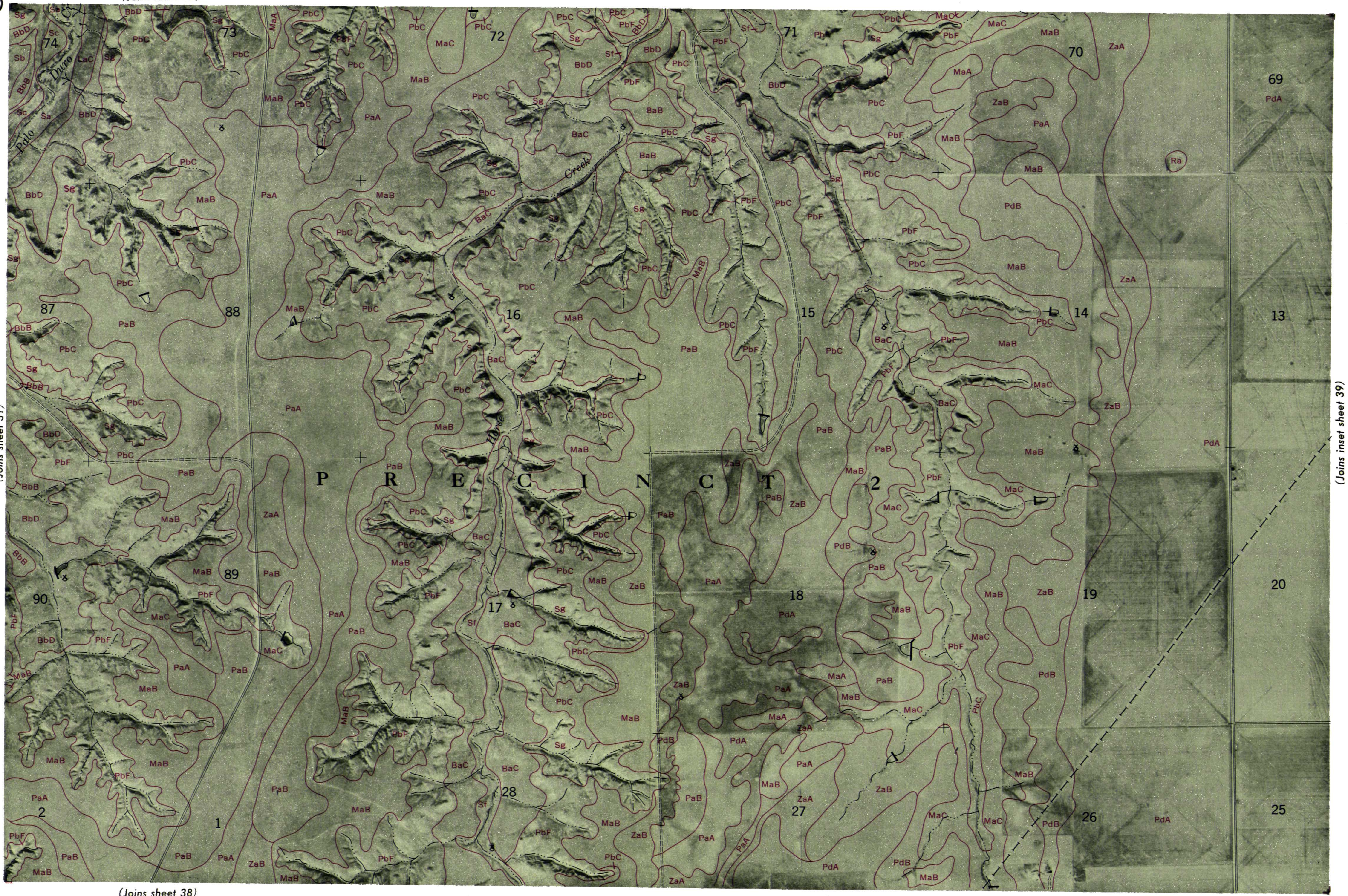
Scale 1:20000

0 5000 Feet

(Joins sheet 25)

N

(Joins sheet 31)



(Joins inset sheet 39)

(Joins sheet 38)

0 1/2 1 Mile

Scale 1:20 000

0 5000 Feet

(Joins sheet 27)

(Joins sheet 34)

(Joins sheet 40)

0 1/2 1 Mile Scale 1:20000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

HANSFORD COUNTY TEXAS - SHEET NUMBER 34

34

(Joins sheet 28)

N

(Joins sheet 33)

(Joins sheet 35)

(Joins sheet 41)

0 1/2 1 Mile

Scale 1:20000

0 5000 Feet

(Joins sheet 29)

35

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

(Joins sheet 34)

(Joins sheet 36)

(Joins sheet 42)

Scale 1:20000

0 1/2 1 Mile

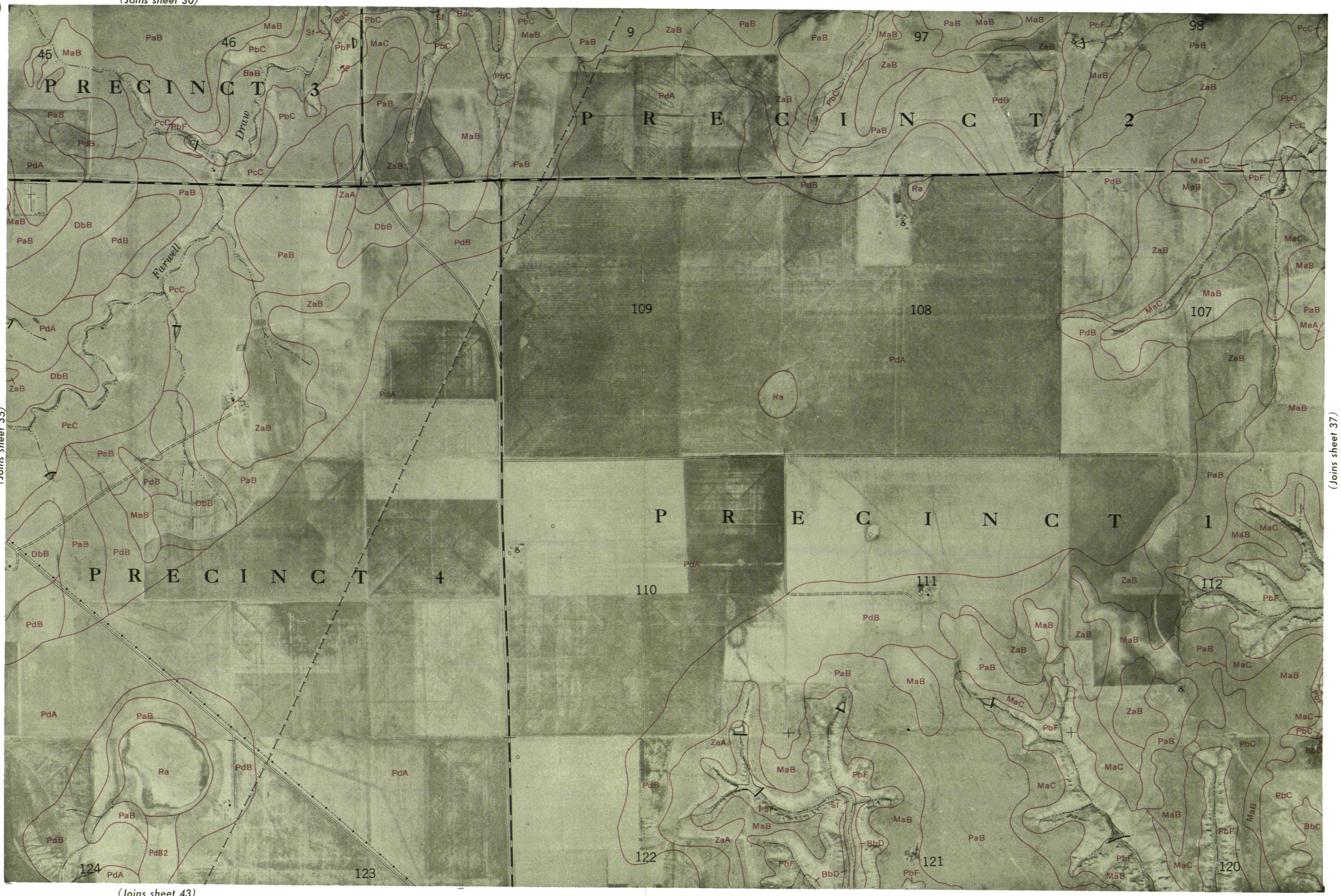
0 5000 Feet

36

HANSFORD COUNTY, TEXAS - SHEET NUMBER 36

(Joins sheet 30)

(Joins sheet 35)



(Joins sheet 37)

(Joins sheet 43)

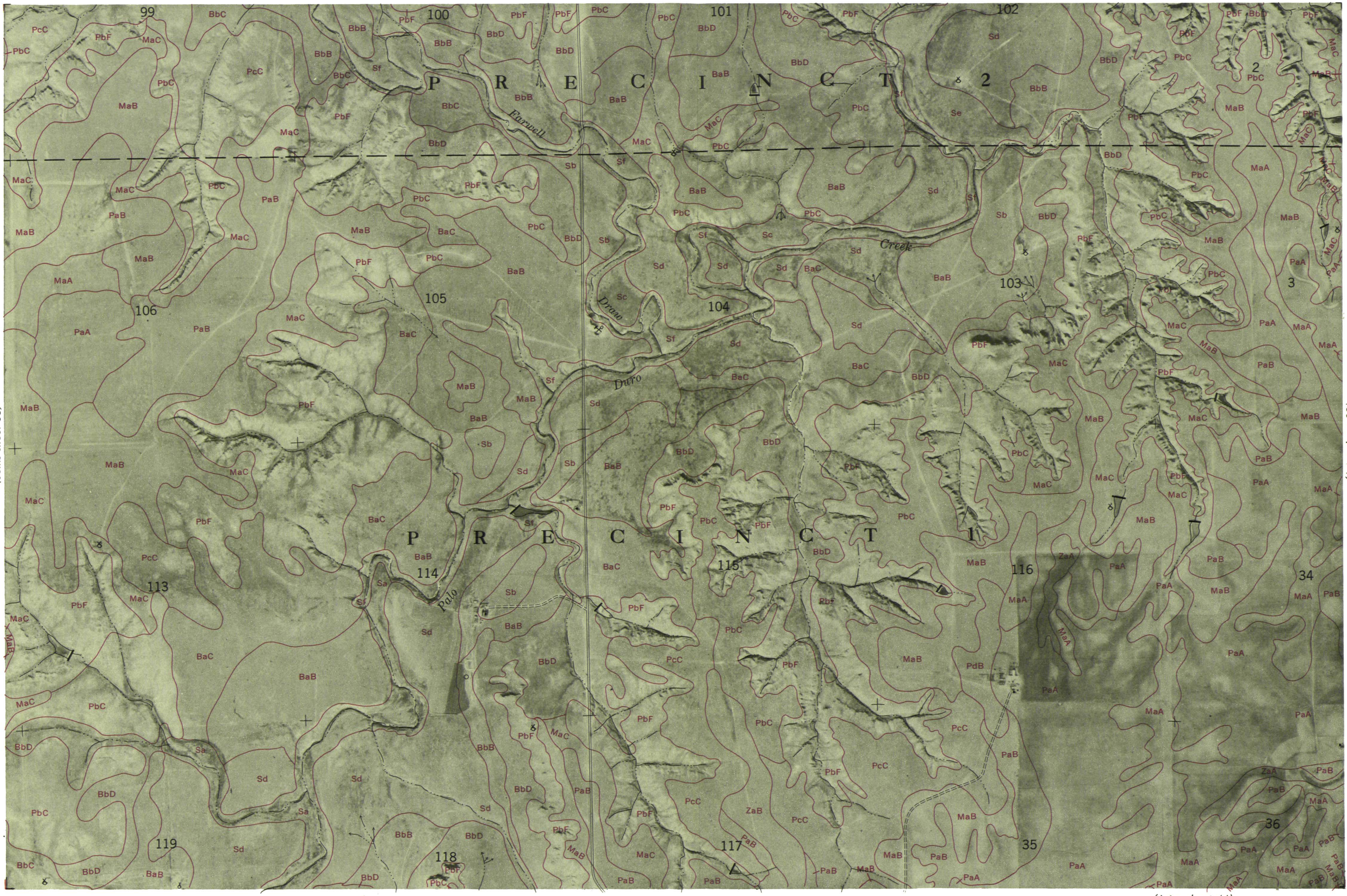
0 ½ 1 Mile

Scale 1:20 000

0 5000 Feet

(Joins sheet 31)

(Joins sheet 36)



(Joins sheet 38)

(Joins sheet 44)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

HANSFORD COUNTY, TEXAS - SHEET NUMBER 38

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite

Section corners shown on this map are indefinite.

(Inset right)

(Joins sheet 38)

(Joins inset sheet 52)

COUNTY
OCHILTREE

(Joins sheet 26)

(Joins sheet 32)

COUNTY
OCHILTREE

N

(Joins left above)

0 ½ 1 Mile

Scale 1:20 000

0 5 000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 40

(Joins sheet 33)

(Joins sheet 46)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

(Joins sheet 34)

(Joins sheet 40)

(Joins sheet 42)

(Joins sheet 47)

0 1/2 1 Mile Scale 1:20000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954

Section corners shown on this map are indefinite.

HANSFORD COUNTY, TEXAS - SHEET NUMBER 42

(Joins sheet 35)

(Joins sheet 41)

(Joins sheet 43)

(Joins sheet 48)

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 43

43

(Joins sheet 36)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

(Joins sheet 42)

(Joins sheet 44)

(Joins sheet 49)

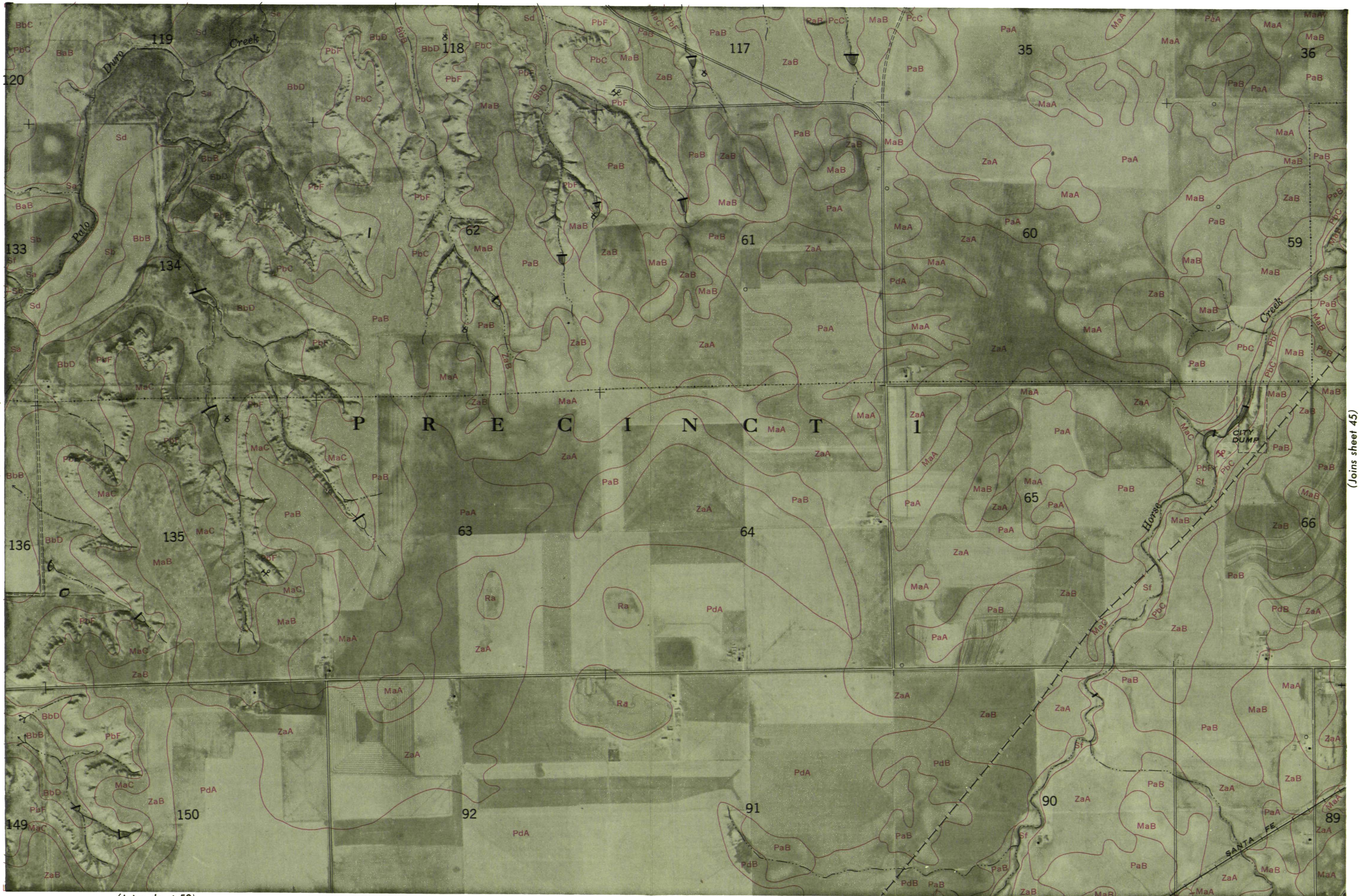
0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

44

(Joins sheet 37)

HANSFORD COUNTY, TEXAS - SHEET NUMBER 44

(Joins sheet 43)



(Joins sheet 45)

(Joins sheet 50)

0 1/2 1 Mile

Scale 1:20000

0 5000 Feet

(Joins sheet 38)

45

(Joins sheet 44)

(Joins inset, sheet 52)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

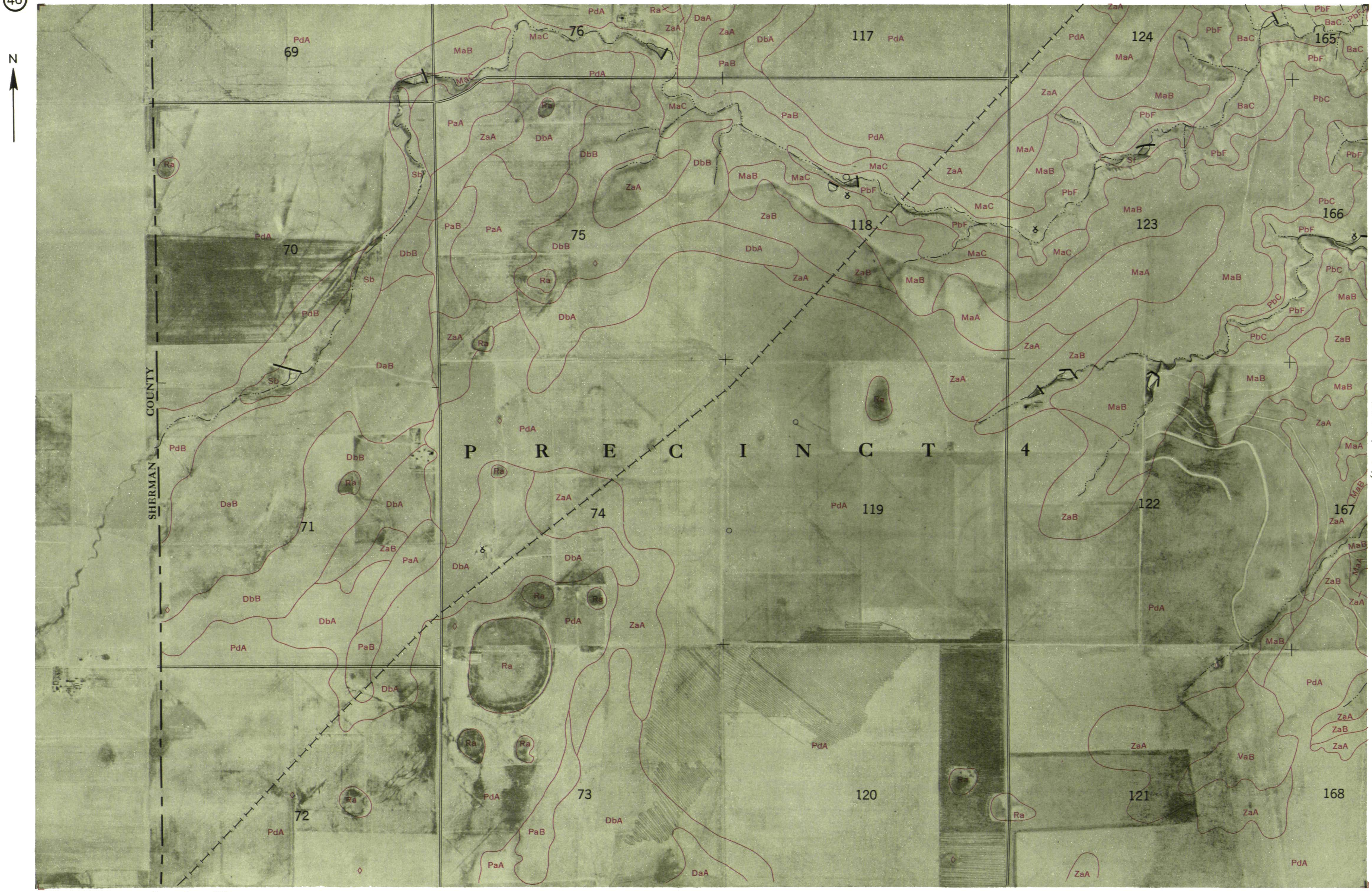
Section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

(Joins sheet 51)

HANSFORD COUNTY, TEXAS - SHEET NUMBER 46

(Joins sheet 40)



(Joins sheet 47)

(Joins sheet 53)

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

HANSFORD COUNTY, TEXAS - SHEET NUMBER 48

(Joins sheet 42)

(Joins sheet 47)

(Joins sheet 49)

(Joins sheet 55)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

(Joins sheet 43)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

(Joins sheet 48)

(Joins sheet 50)

(Joins sheet 56)

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 50

0 1/2 1 Mile Scale 1:20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

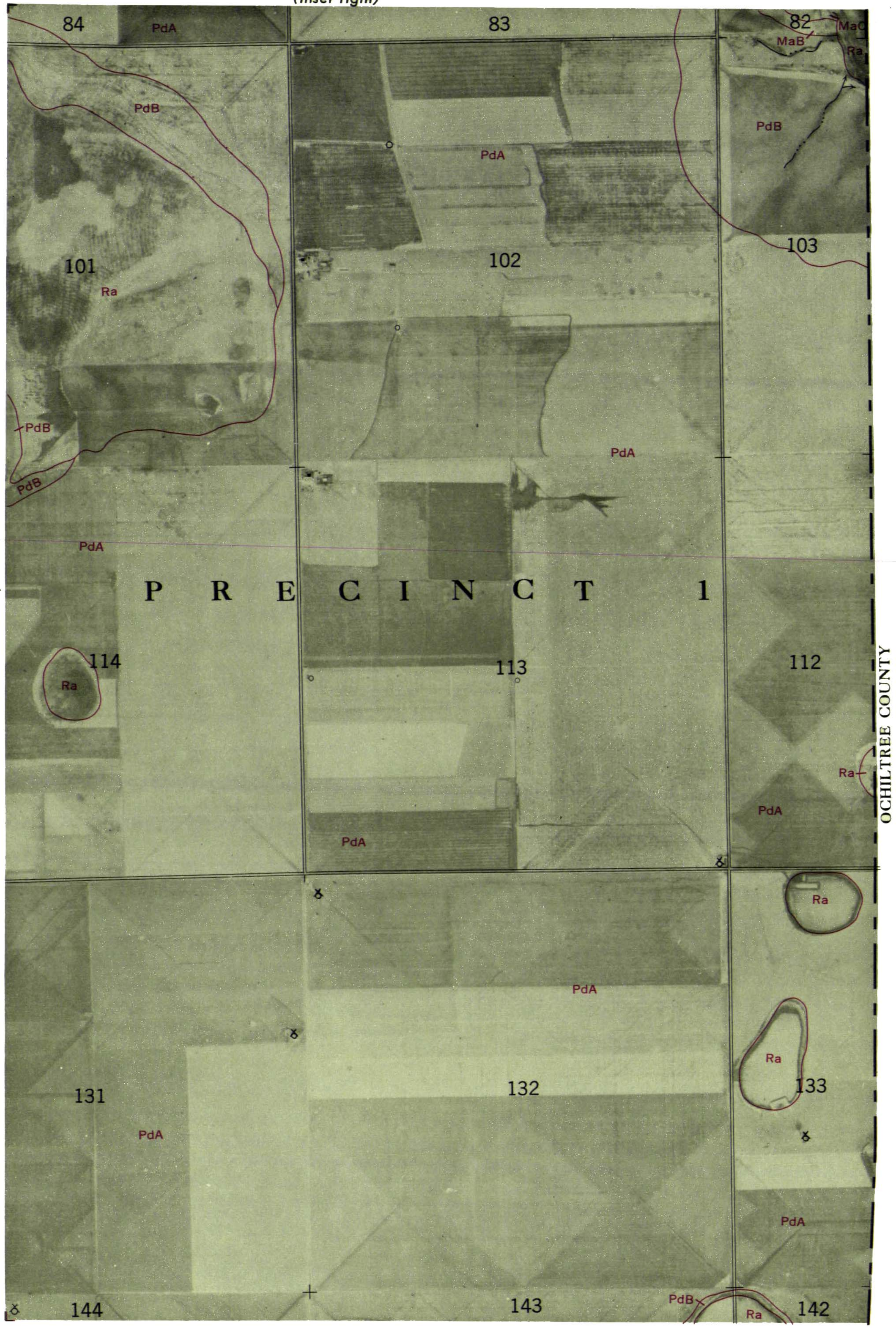
Section corners shown on this map are indefinite.

HANSFORD COUNTY, TEXAS - SHEET NUMBER 52

(Inset right)

N

(Joins sheet 51)



OCHILTREE COUNTY

(Joins inset, sheet 65)

(Joins sheet 39)

(Joins sheet 45)

OCHILTREE COUNTY

(Joins left above)

0 ½ 1 Mile

Scale 1:20 000

0 5000 Feet

(Joins sheet 46)

(Joins sheet 54)

(Joins sheet 59)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954

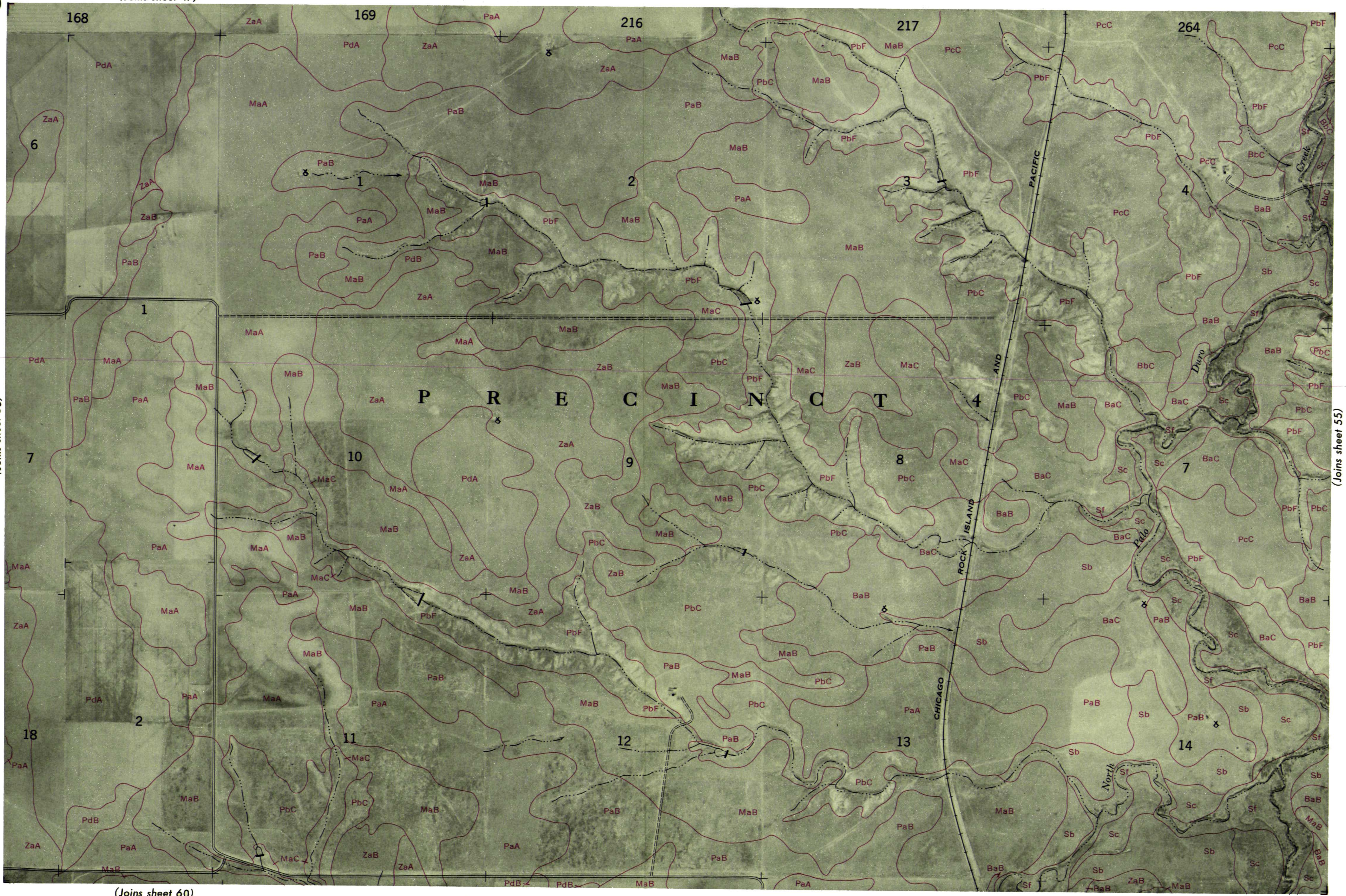
Section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 54

(Joins sheet 47)

(Joins sheet 53)

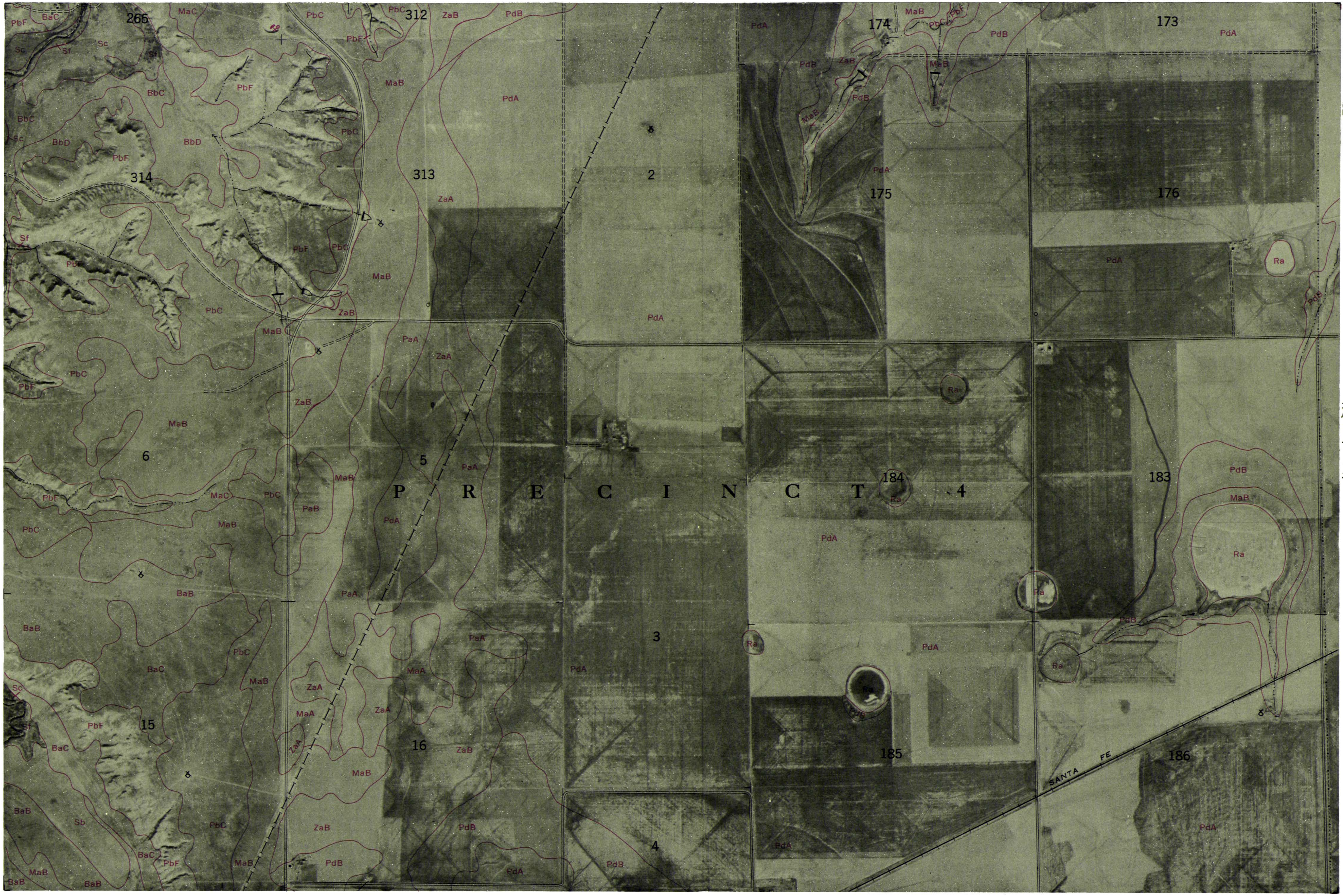


(Joins sheet 55)

(Joins sheet 60)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

(Joins sheet 48)



(Joins sheet 54)

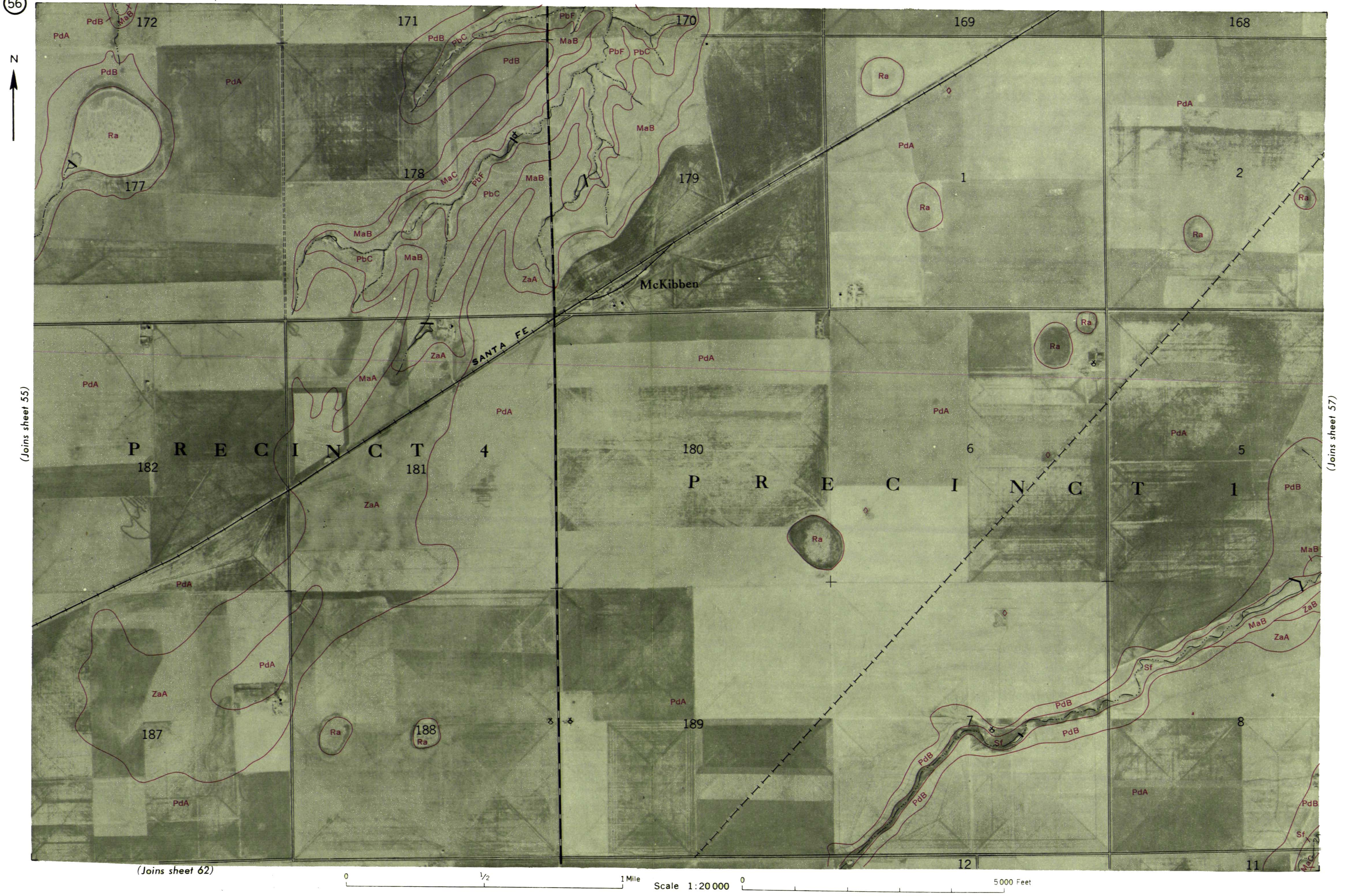
(Joins sheet 56)

(Joins sheet 61)

0 1/2 1 Mile Scale 1:20000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.


(Joins sheet 49)
(Joins sheet 55)
(Joins sheet 57)
(Joins sheet 62)
N
McKibben
SANTA FE
PRECINCT 4
PRECINCT 1
172
171
170
169
168
177
178
179
1
2
182
181
180
6
5
187
188
189
7
8
12
11
PdA
PdB
MaB
PbF
PbC
MaC
Ra
ZaA
MaA
Sf
ZaB
0
1/2
1 Mile
Scale 1:20 000
0
5000 Feet

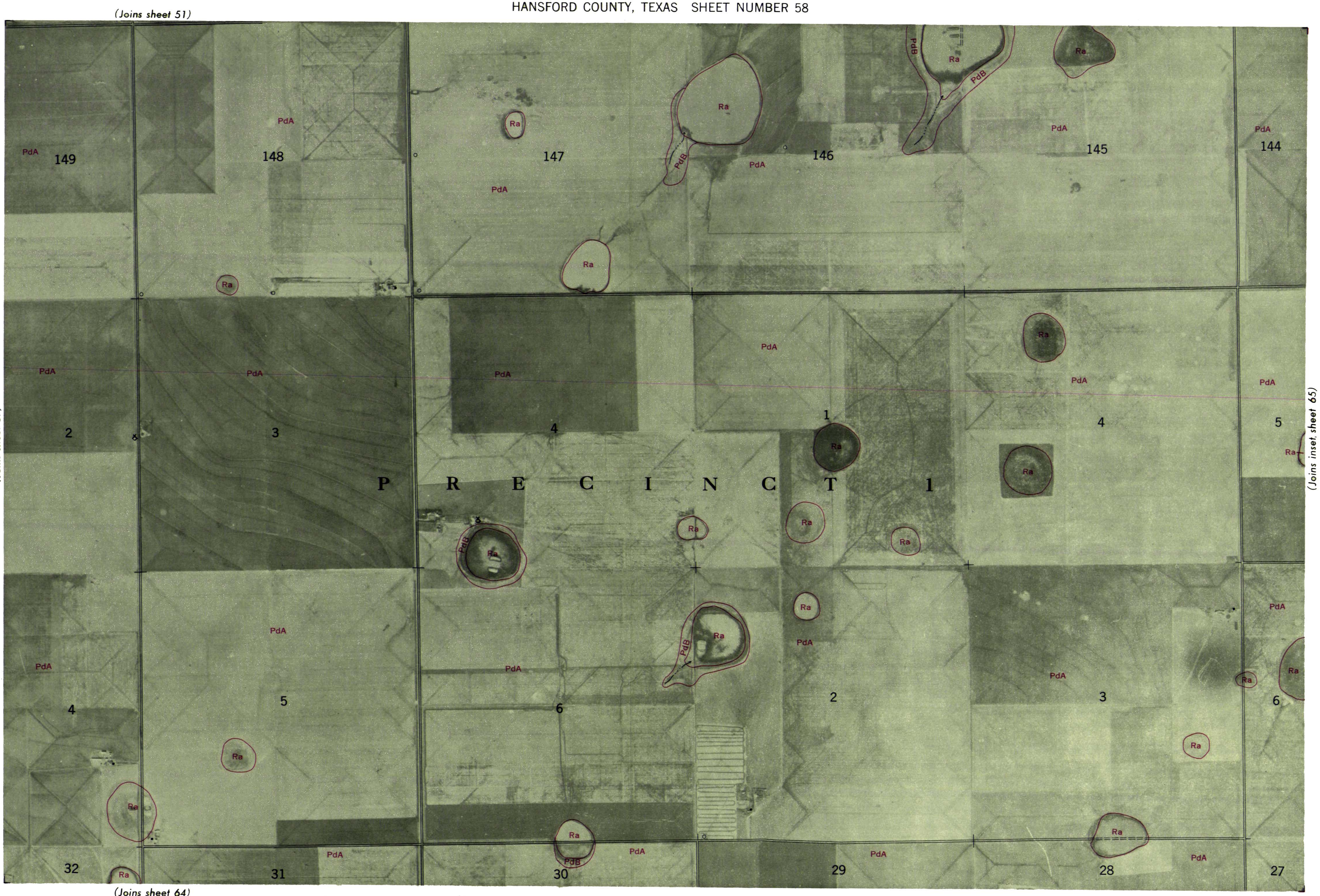
This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

58

HANSFORD COUNTY, TEXAS SHEET NUMBER 58



0 ½ 1 Mile

Scale 1:20 000

0 5000 Feet

(Joins sheet 53)

(Joins sheet 60)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

0 1/2 1 Mile Scale 1:20000 0 5000 Feet

HANSFORD COUNTY, TEXAS - SHEET NUMBER 60

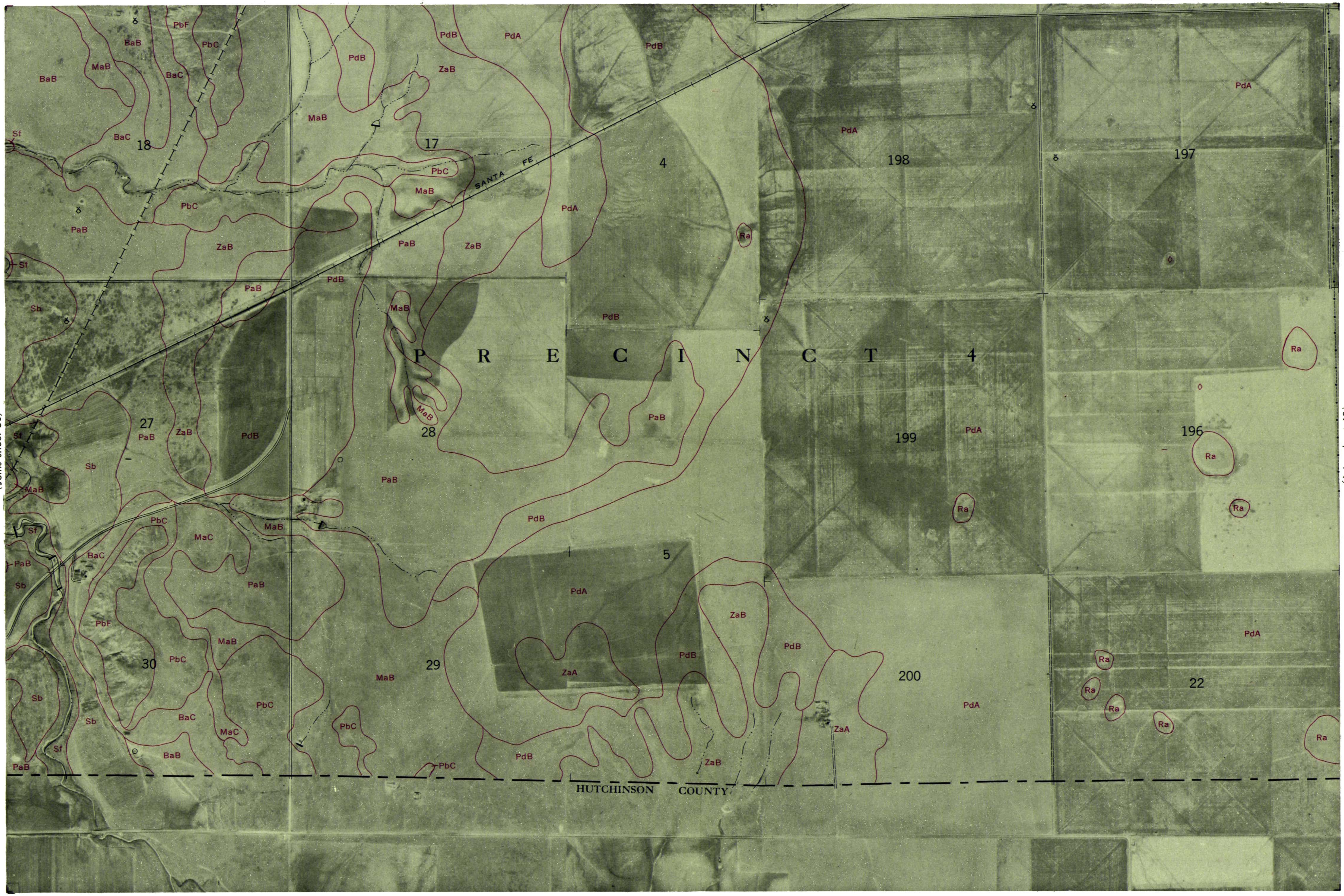
(Joins sheet 54)

(Joins sheet 59)

(Joins sheet 61)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

(Joins sheet 55)



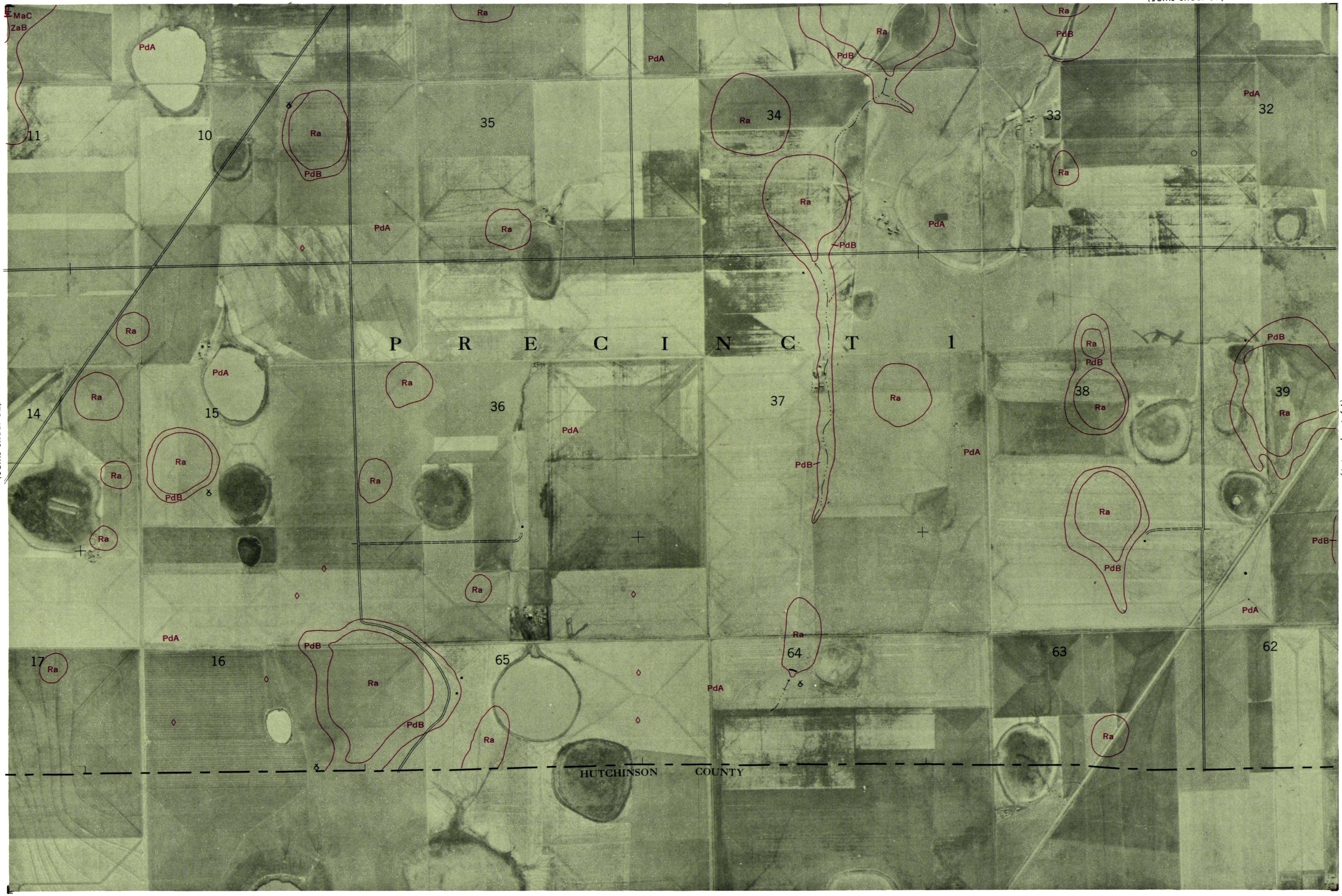
Section corners shown on this map are indefinite.

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

0 1/2 1 Mile Scale 1:20000 0 5000 Feet

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

(Joins sheet 57)



(Joins sheet 62)

(Joins sheet 64)

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20000 0 5000 Feet

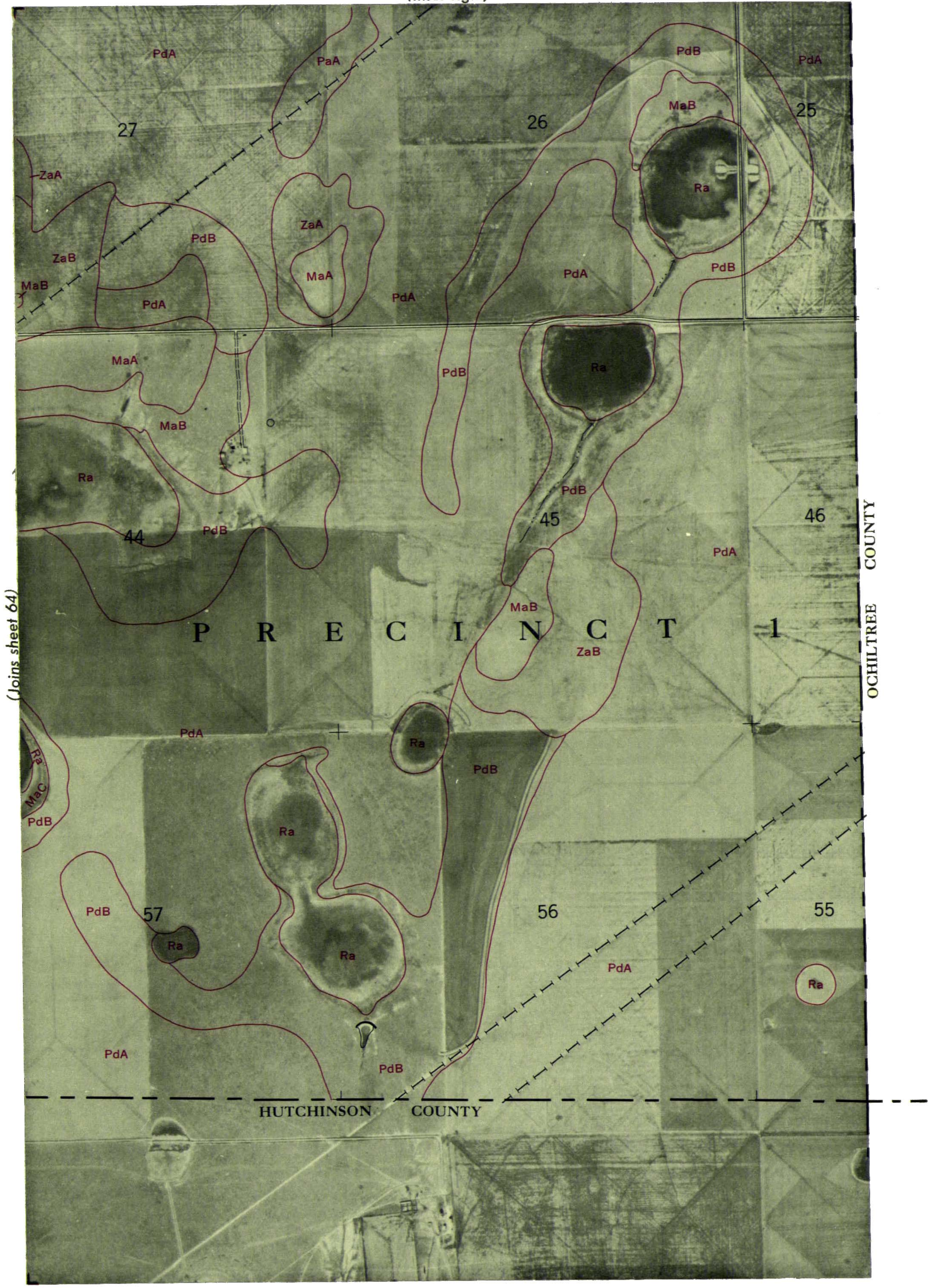
64

HANSFORD COUNTY, TEXAS - SHEET NUMBER 64

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This is one of a set of maps prepared by the Soil Conservation Service, U. S. Department of Agriculture, for a soil survey report of this area. For information regarding the complete soil survey report, write the Soil Conservation Service, U. S. Department of Agriculture, Washington 25, D. C. This map compiled from aerial photographs flown in 1954.

Section corners shown on this map are indefinite.



Scale 1:20000

0 ½ 1 Mile

0 5000 Feet

N